# Liver Tumor Diagnosis and Interpretation Web Application

## Title:

**Multi-Phase Liver Tumor Classification & Interpretation with Visual Risk Assessment and Vascular Context**

## Problem Statement:

Liver cancer diagnosis using CT images is complex due to the varying appearance of tumors across arterial, venous, and delayed phases. Clinicians require not just classification (HCC, CCA, benign), but context — including tumor boundaries, surrounding vessels, and confidence of predictions. Current systems offer isolated outputs or limited interpretability.

## Core Objectives:

Build a functional web application that: - Accepts either **single-phase** or **multi-phase** CT scan images. - Predicts **HCC**, **CCA**, or **benign** tumor type. - Displays **model confidence score** and a qualitative **risk level**. - Highlights **tumor regions** using Grad-CAM. - (Optionally) includes **vascular visualization** (if vessels can be approximated). - Offers a **drag-and-drop** interface for clinicians.

## Dataset:

**PLC-CECT Dataset (SciDB.cn)**  
Link: [PLC-CECT Dataset](https://www.scidb.cn/en/detail?dataSetId=d685a0b9f8974a2a9d7c880be1dc36e9)

* 287 patients with HCC, CCA, and benign liver tumors.
* Triphasic CT scans: **Arterial**, **Venous**, **Delayed**.
* Annotations: Tumor masks are provided.
* Format: NIfTI (.nii.gz)

## Novelty & Research Value:

✅ **Multi-Task Hybrid Pipeline**: - Segments **tumor regions** using U-Net variant. - (Optionally) Segments **vascular structures** using pseudo-labeling or vessel enhancement filters (e.g., Frangi filter). - Classifies tumor type based on segmented ROI + full scan.

✅ **Robust Input Handling**: - Works with single or multi-phase inputs. - Uses phase-aware embeddings or shared encoders for cross-phase consistency.

✅ **Clinical Explainability**: - Grad-CAM visualizations. - Confidence & risk level displayed.

✅ **Web Deployment**: - Usable by non-technical clinicians. - Easy drag-and-drop interface with output reports.

✅ **Feasibility for Patent**: - Combines tumor + vascular context in one pipeline. - Includes hybrid visual + decision support logic.

## System Architecture:

### 1. **Preprocessing**

* Load NIfTI and convert to PNG slices.
* Normalize intensity values.
* Resize and stack phases.
* Perform optional vessel enhancement.

### 2. **Tumor Segmentation Module**

* U-Net or Attention U-Net.
* Trained on tumor masks.
* Outputs segmentation mask.

### 3. **(Optional) Vessel Segmentation**

* Vessel highlighting using filters.
* Multi-task loss function combining tumor + vessel regions.

### 4. **Classification Module**

* CNN with phase fusion (if multi-phase).
* ROI-focused classification.
* Predicts: HCC / CCA / Benign.

### 5. **Explainability & Risk Score**

* Grad-CAM heatmap overlay.
* Monte Carlo Dropout for uncertainty estimation.
* Risk level bucketed into: **Low / Moderate / High**.

### 6. **Web Interface**

* Built with **Streamlit / Flask + React**.
* Drag-and-drop uploader for scans.
* Display:
  + Tumor highlight
  + Predicted label
  + Confidence (%)
  + Risk Level
  + Downloadable Report (PDF)

## Timeline (1 Week Plan)

### Day 1–2:

* Dataset download + conversion
* Tumor segmentation pipeline
* Vessel extraction (pseudo-label)

### Day 3–4:

* Classification model training
* Grad-CAM + risk calibration

### Day 5–6:

* Web interface frontend
* Backend integration + testing

### Day 7:

* Final testing
* Packaging + Deployment

## Tools & Libraries:

* PyTorch / TensorFlow
* MONAI (for medical imaging models)
* OpenCV, SimpleITK
* Streamlit / Flask
* Grad-CAM: Captum / TorchCAM
* Docker (optional)

## Outputs:

* .nii.gz to PNG processor
* Tumor mask + (optional) vessel mask overlay
* Class prediction + score
* Grad-CAM visualization
* Web app interface

## Final Note:

This project leverages multi-phase liver CT imaging to offer not just diagnosis but **interpretation and trust**, empowering clinicians with clear visuals and decision confidence. With strong novelty and direct clinical value, it is ideal for publication, demo presentation, or even pilot deployment.

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