

# LIVERGUARD

**AI-Driven IoT System for Early Liver  
Disease Detection and Monitoring**

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# PROJECT OVERVIEW

Key components include:

TEMPERATURE  
SENSORS

THERMAL CAMERA

SKIN SENSORS

The project leverages Artificial Intelligence (AI) and the Internet of Things (IoT) to:

Enable continuous remote monitoring

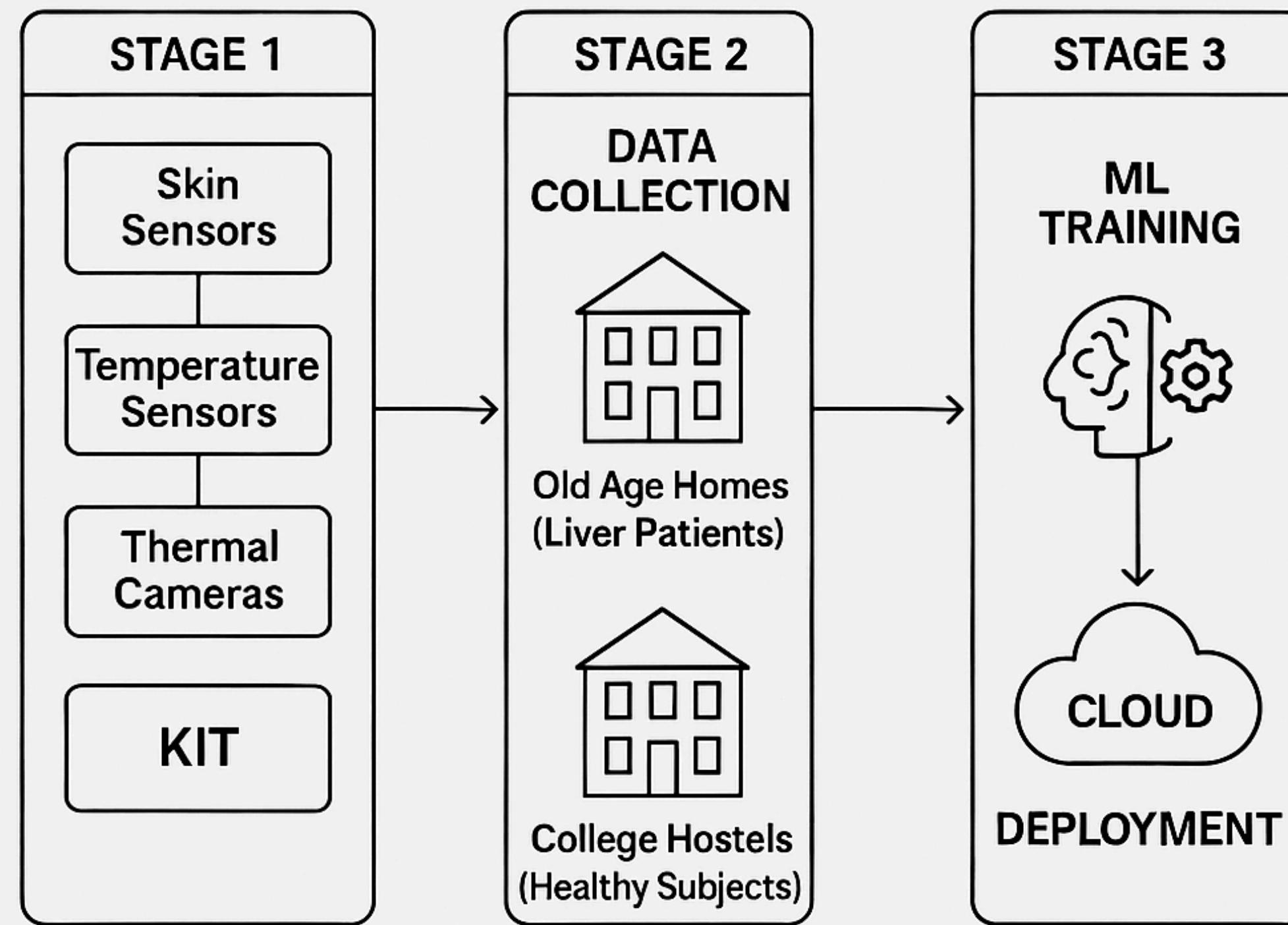
Improve diagnostic accuracy

Support early medical intervention



# ARCHITECTURE

## LIVERGUARD PROJECT ARCHITECTURE





# PARAMETERS

## Skin impedance:

Skin impedance measured by a soft, adhesive on-skin sensor offers a non-invasive way to distinguish between healthy and fatty liver tissues by detecting changes in electrical properties related to fat infiltration.

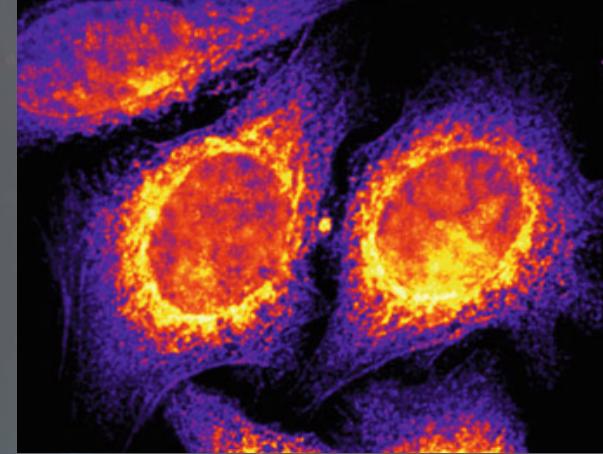


## Skin Colour:



Skin colour measurement provides a rapid, non-invasive method for detecting changes associated with liver disease, especially jaundice and hyperpigmentation.

## Thermal Imaging:



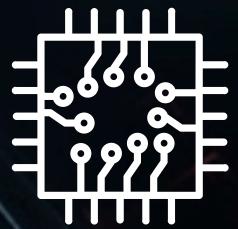
Thermal imaging provides a non-contact approach to detect abnormal temperature patterns on the skin surface, which can signal inflammation or altered blood flow caused by underlying liver dysfunction.



# LITERATURE REVIEW

Parameter	Paper Link	Outcomes
SKIN IMPEDANCE	<a href="https://www.ccjm.org/content/88/4/210">https://www.ccjm.org/content/88/4/210</a>	In this paper the patient was suffering from puffy hands leading to fluid retention which was linked to liver cirrohsis
	<a href="https://PMC9257870/">https://PMC9257870/</a>	This paper shows change in electrolyte levels of patients with different liver diseases
SKIN COLOUR	<a href="https://www.mdpi.com/2673-4532/6/1/6">https://www.mdpi.com/2673-4532/6/1/6</a>	This paper shows links of skin colour with jaundice in new borns
	<a href="https://www.dermatologypaper.com/article/view/83/4-2-5">https://www.dermatologypaper.com/article/view/83/4-2-5</a>	In this reasearch they used the same sensor which is used in our prototype for jaundice detection
THERMAL IMAGING	<a href="https://PMC7511937/#Sec7">https://PMC7511937/#Sec7</a>	Shows links of thermal image with NAFLD
	<a href="https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5244427">https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5244427</a>	Blue light emission trends with bilurubin

# HARDWARE USED



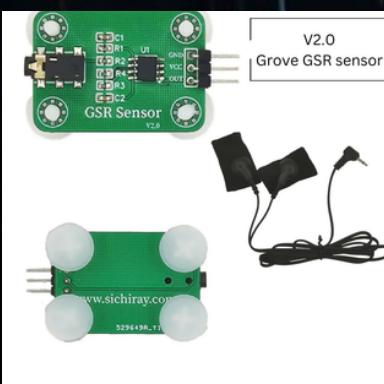
## Important Sensors



Color Sensor  
RGB Module

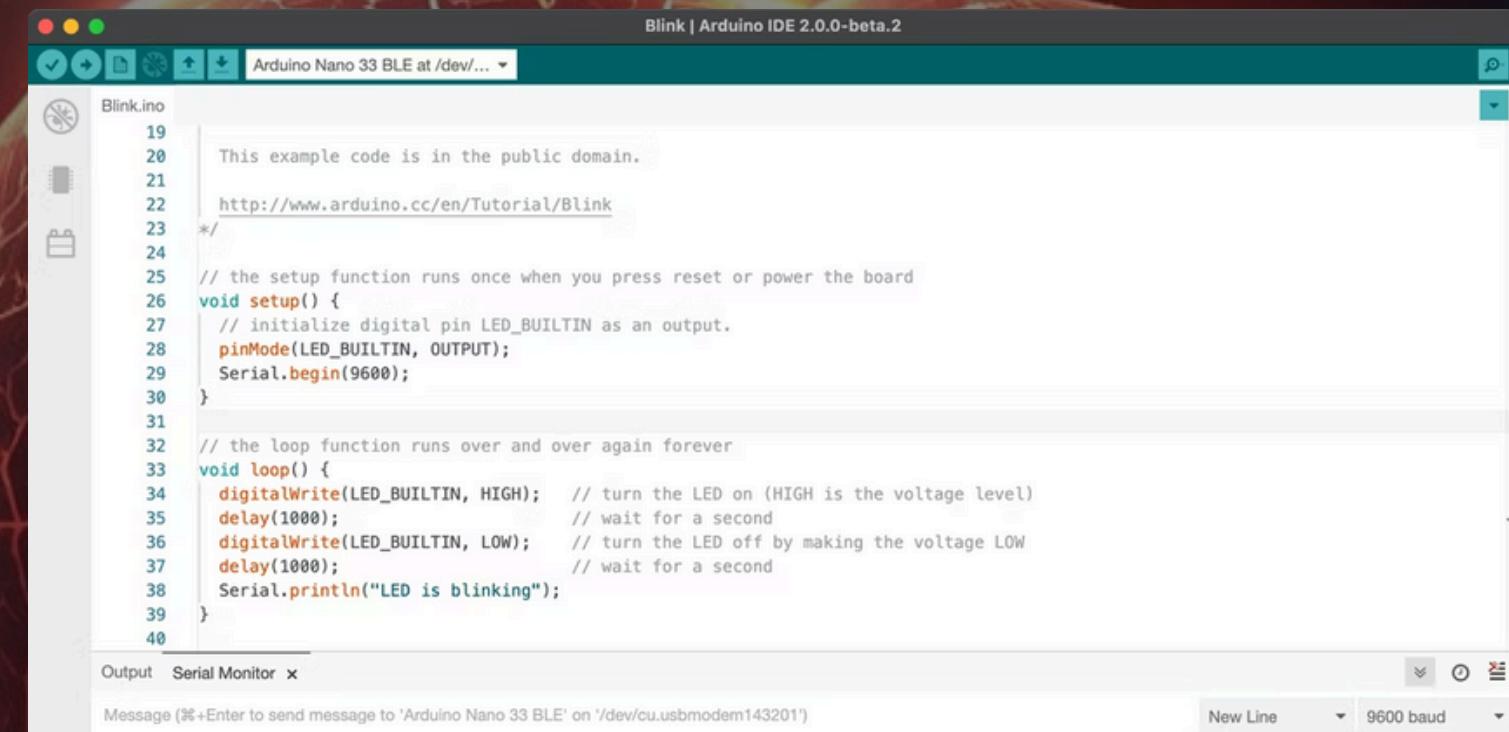


IR Array Thermal  
Imaging Camera



Galvanic Skin  
Response Module  
Current Sensor Kit

## IDE AND MICROCONTROLLER USED



### Arduino IDE:

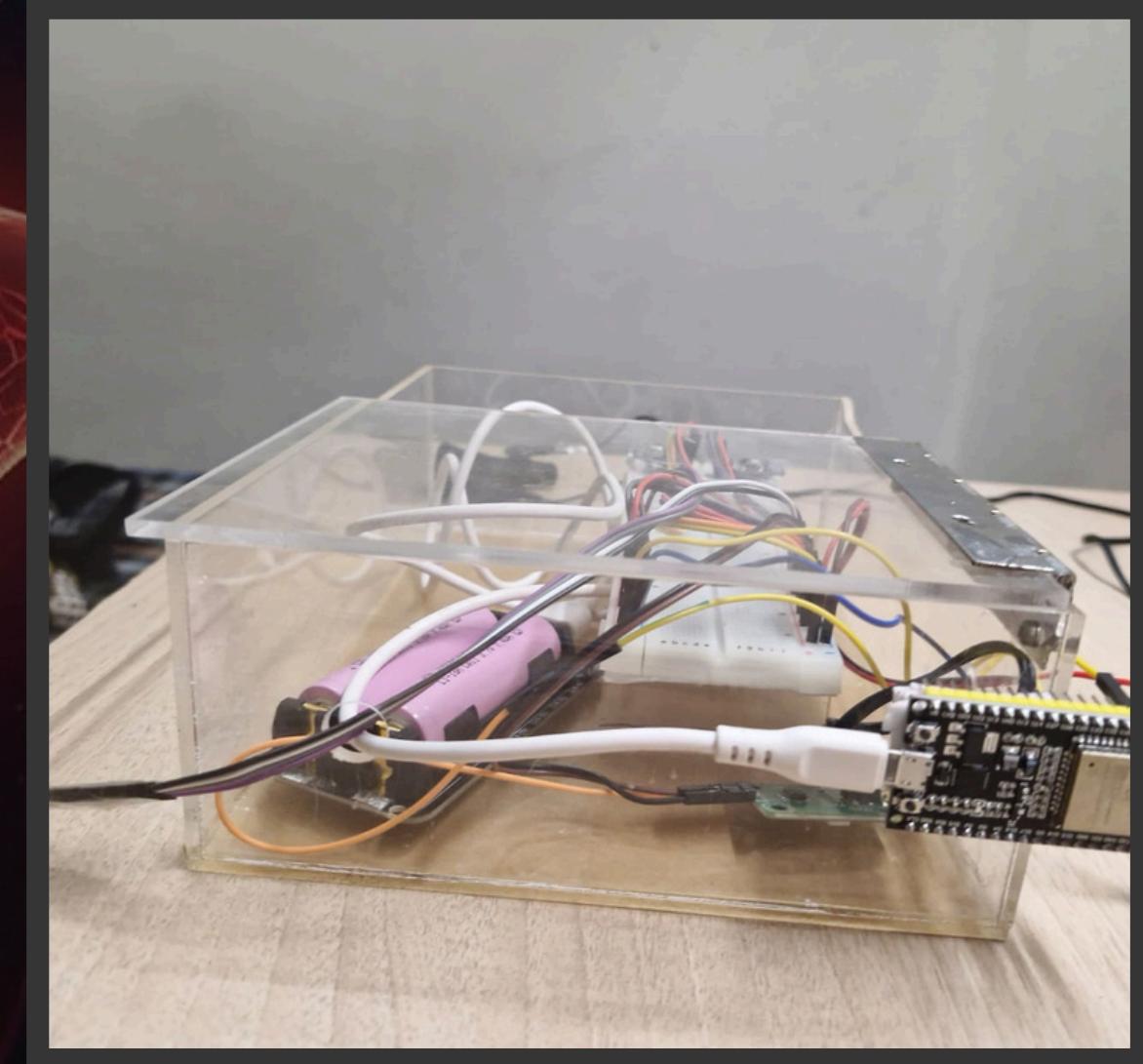
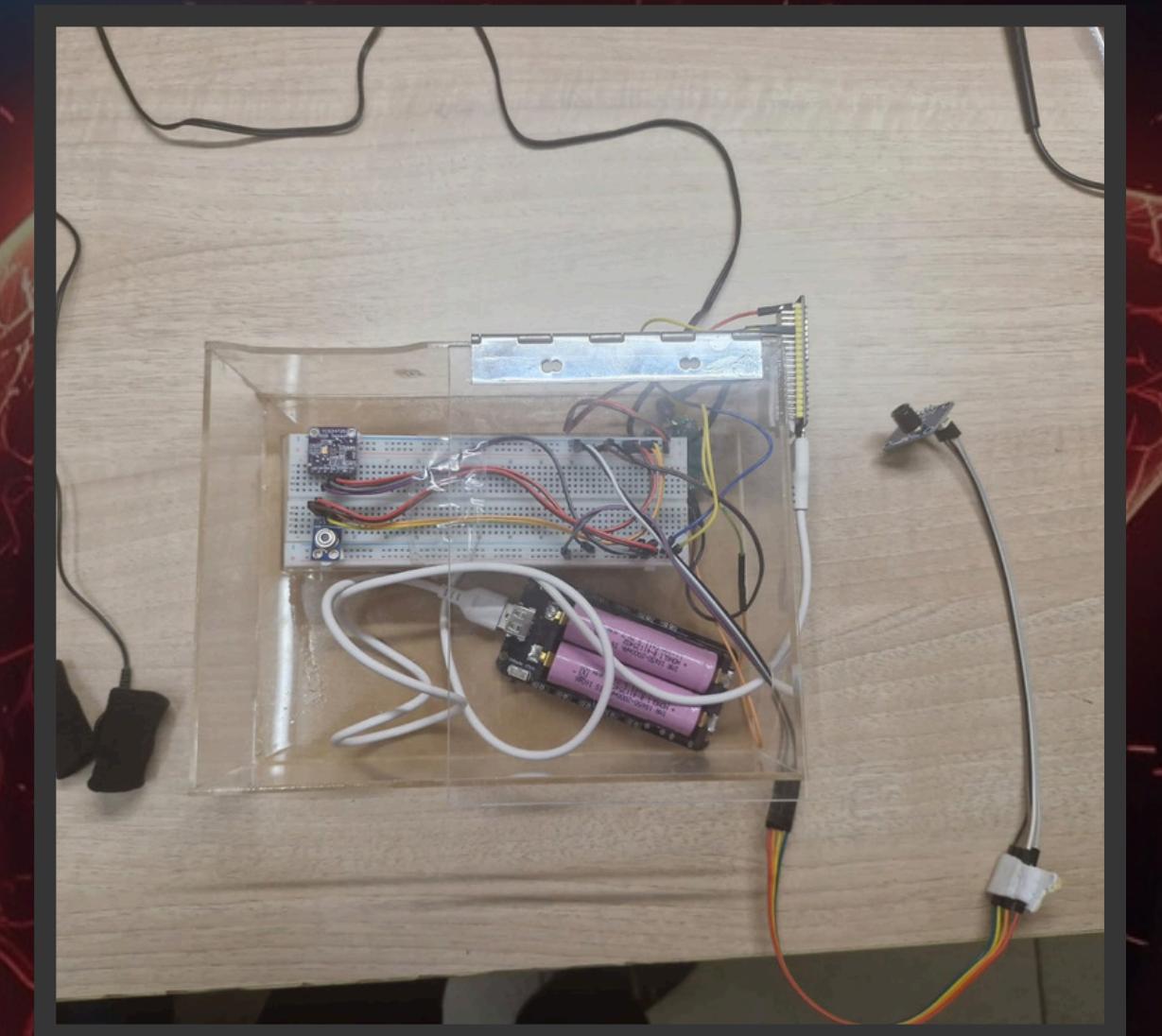
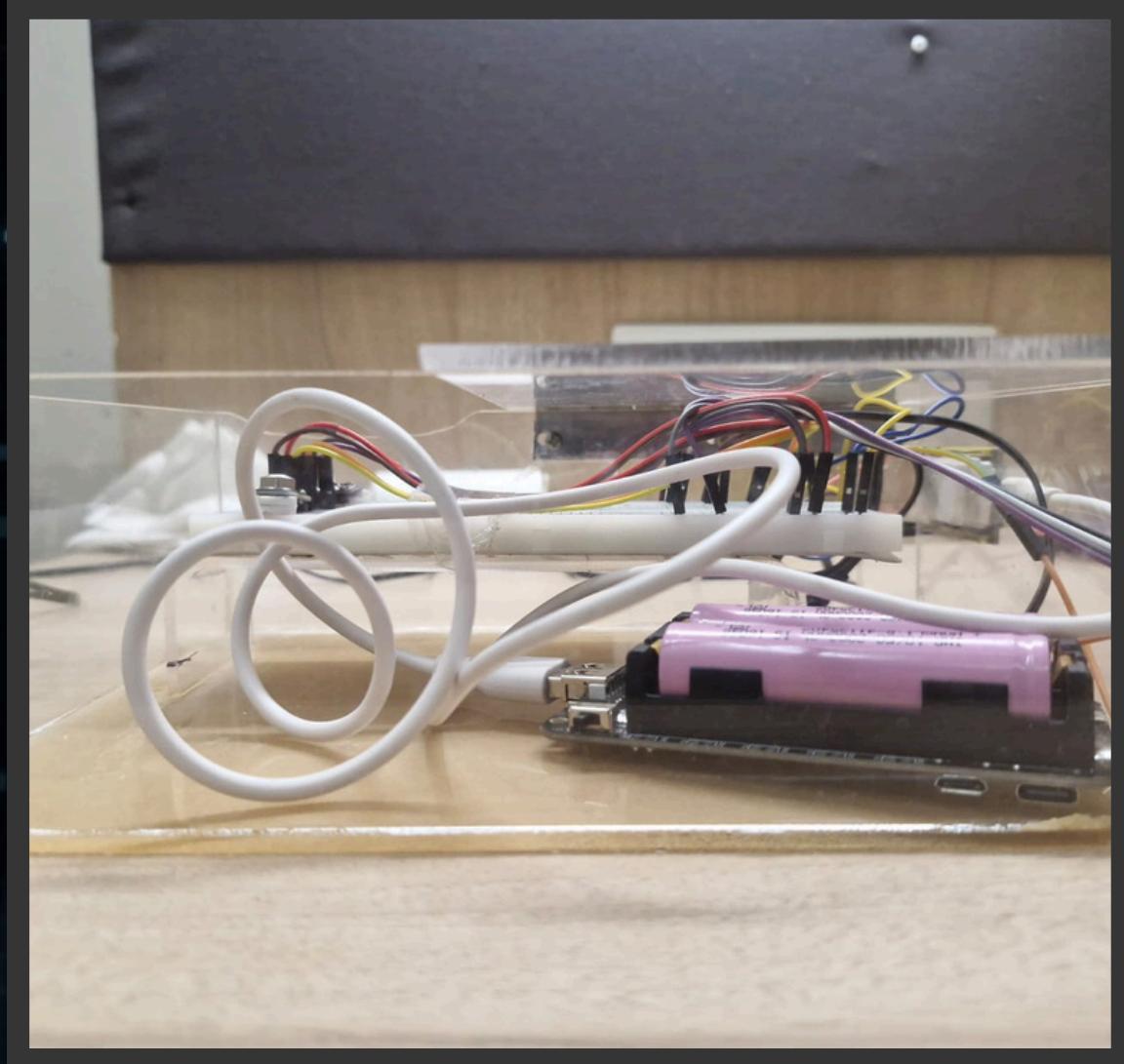
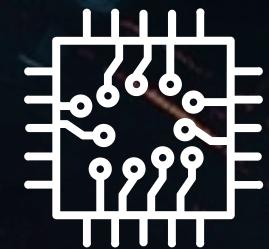
- Easy platform for coding and uploading to microcontrollers
- Supports many sensors and libraries
- Widely used and beginner-friendly



### ESP32

- Powerful microcontroller with WiFi/Bluetooth
- Connects to multiple sensor

# HARDWARE



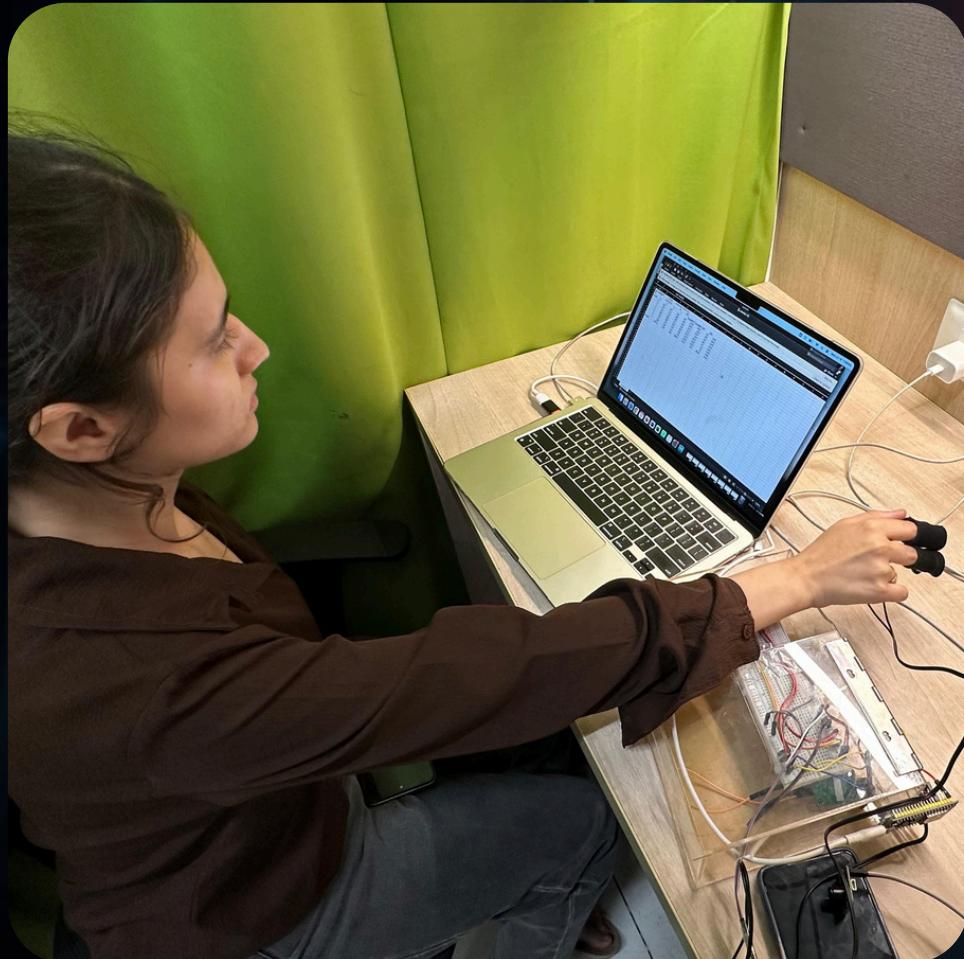
*The final product has been fabricated using acrylic sheets and laser cutting technology, and includes a movable closing flap that helps maintain uninterrupted connections.*

# DATASET COLLECTION

## 1) Old-Age Home :



## 2. College Students & guards :



# INTERFACE

## SENSOR INPUT PAGE

**ESP32 Sensor Logger**

Liver Healthy: Yes Age: 87      Gender: Male Weight (kg): 1221      Height (cm):  
129872918      Set Patient Info

Patient info set: Liver Healthy: Yes, Age: 87, Gender: Male, Weight: 1221 kg, Height: 129872918 cm

Not recording.  
[Download CSV](#)

## CSV FILE GENERATED

Liver Heal	Age	Gender	Weight (kg)	Height (cm)							
Sample	R	G	B	C	Temp90614	Temp90640	GSR	BMI			
1	468	327	222	1012	29.93	35.74	762	20.28			
2	385	273	185	839	30.05	35.79	769	20.28			
3	377	259	174	805	30.05	35.64	765	20.28			
4	353	239	161	748	30.03	35.63	755	20.28			
5	436	286	191	906	30.31	35.44	775	20.28			
6	409	269	179	851	30.19	35.33	770	20.28			
7	402	265	177	839	30.15	35.48	763	20.28			
Average	404.29	274	184.14	857.14	30.1	35.58	765.57	20.28			

# REAL- TIME APP DEPLOYMENT

» Fork ⚙️

## Your Health Assessment Results

OVERALL ASSESSMENT

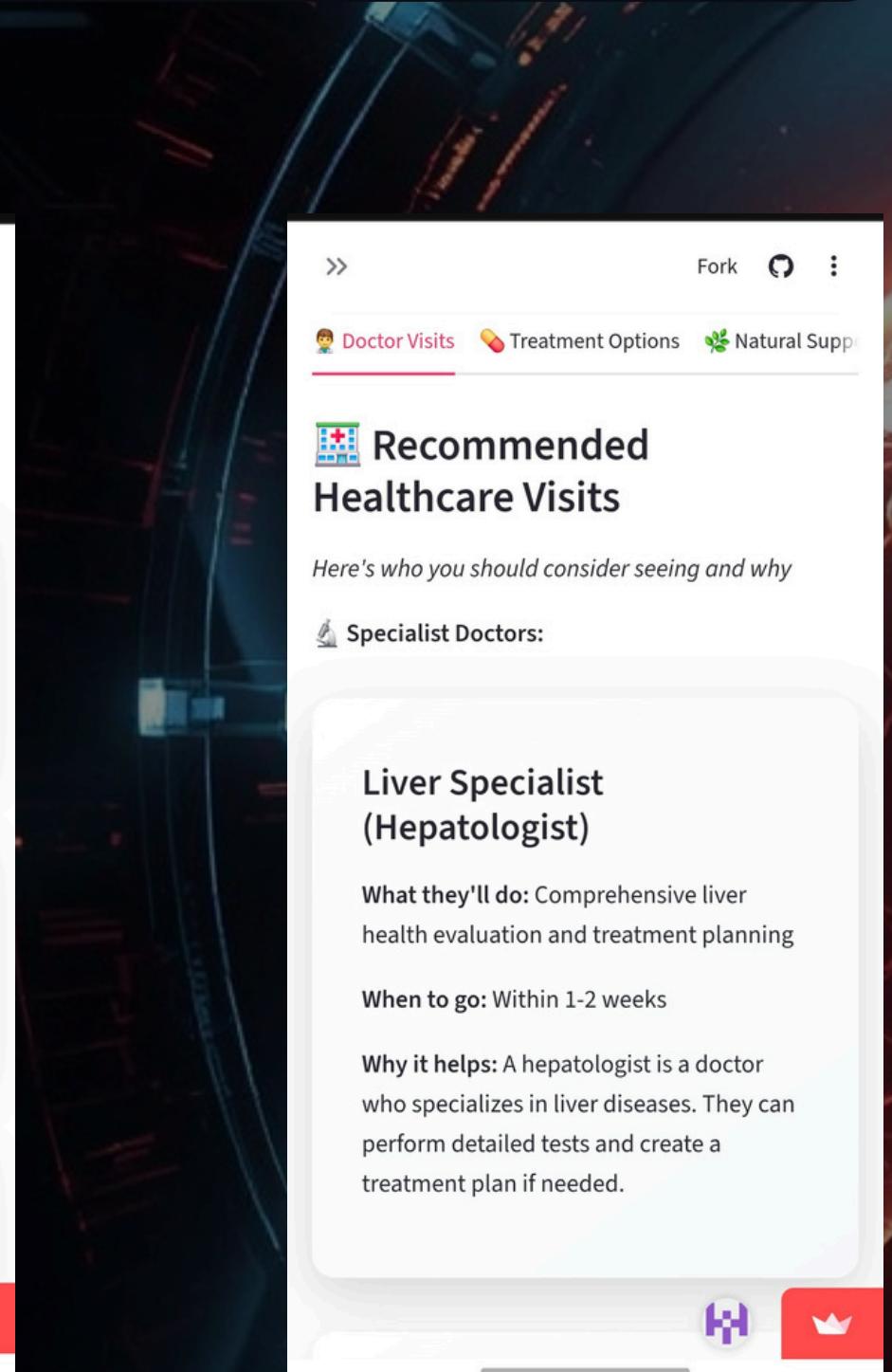
**Needs Attention**

RISK LEVEL

**High**

PRIORITY LEVEL

**Urgent**  



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## Recommended Healthcare Visits

Doctor Visits Treatment Options Natural Supp

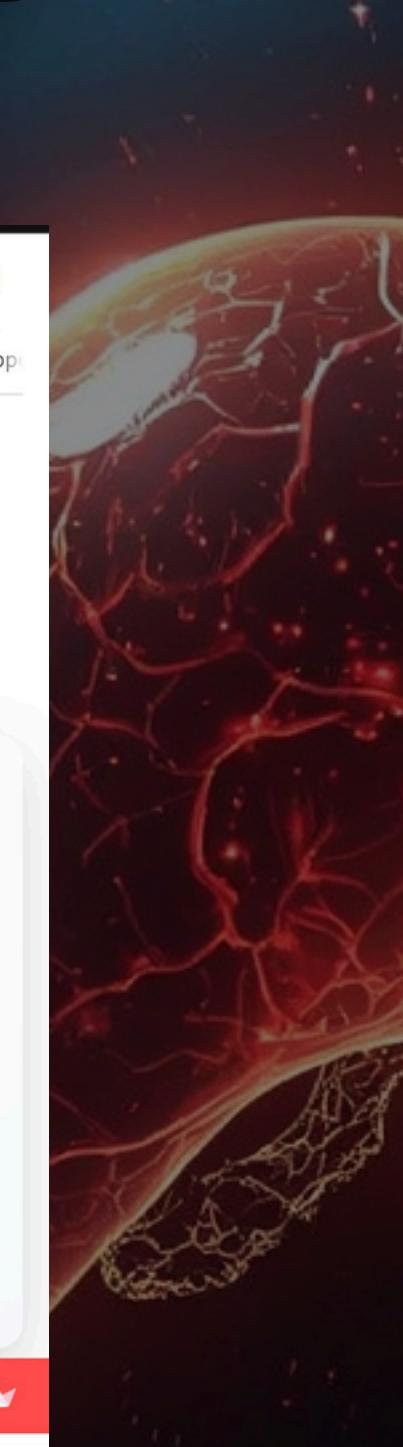
**Specialist Doctors:**

**Liver Specialist (Hepatologist)**

**What they'll do:** Comprehensive liver health evaluation and treatment planning

**When to go:** Within 1-2 weeks

**Why it helps:** A hepatologist is a doctor who specializes in liver diseases. They can perform detailed tests and create a treatment plan if needed.



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## Personal Information

Your Age (years) 35 - +

Gender Male

BMI (Body Mass Index) 25.00 - +

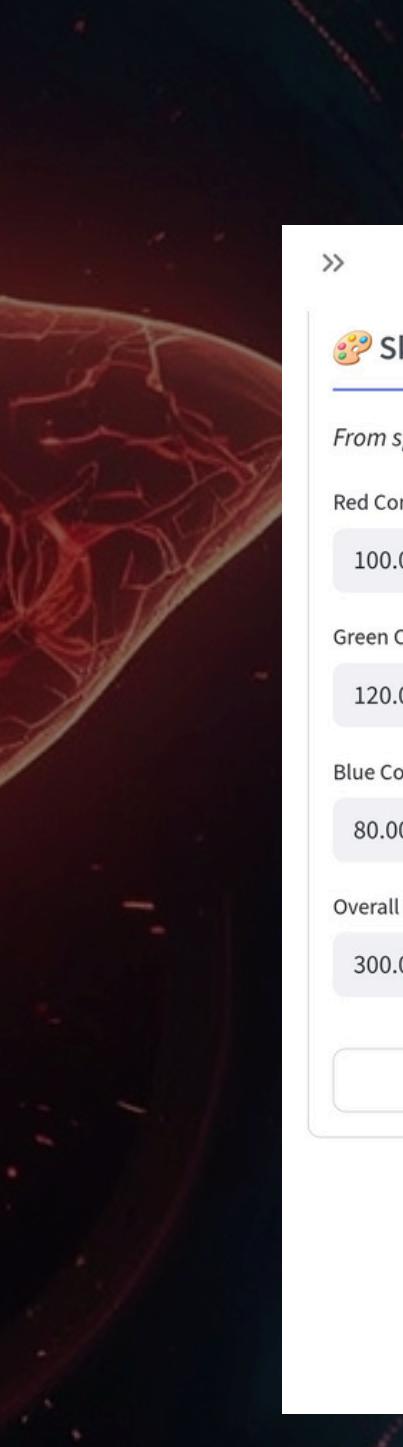
## Body Measurements

Body Temperature (°C) 37.00 - +

Liver Temperature (°C) 37.50 - +

Stress Level (GSR) 25.00 - +

**Skin Color Analysis**   



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## Skin Color Analysis

From special color sensor readings

Red Component 100.00 - +

Green Component 120.00 - +

Blue Component 80.00 - +

Overall Intensity 300.00 - +

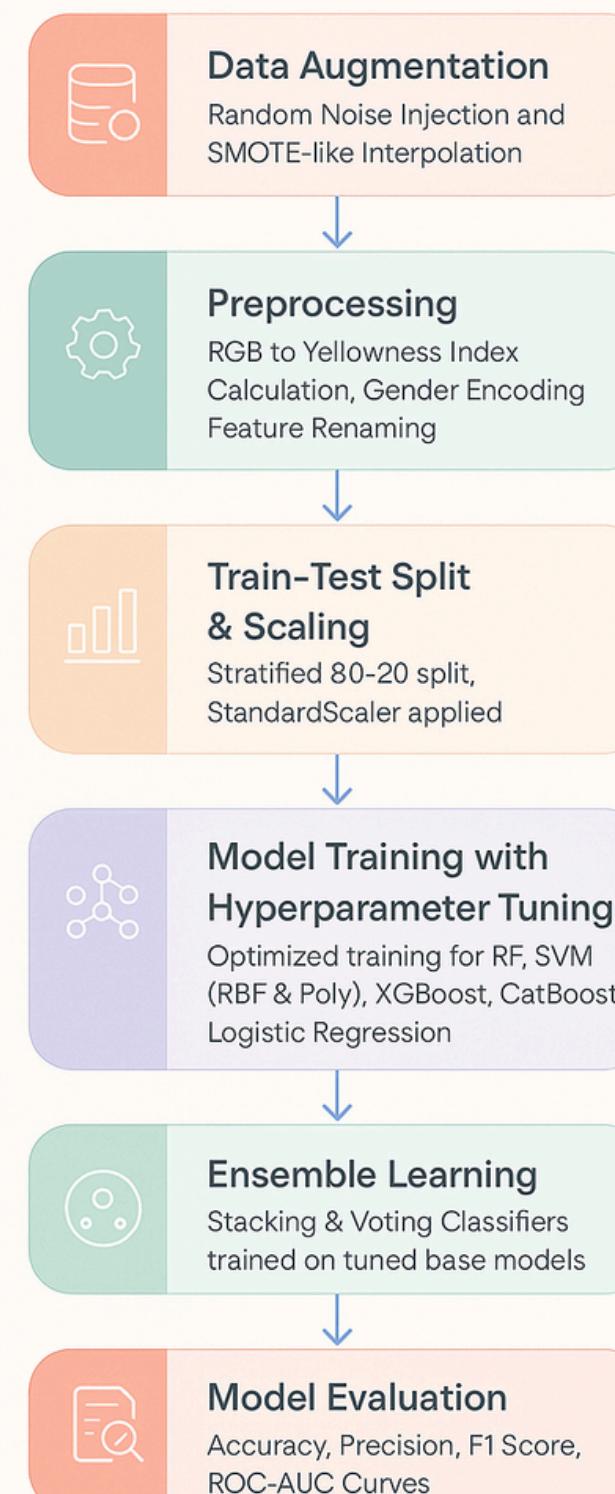
**Get My Health Assessment**  



# ML ARCHITECTURE

## AI Architecture for LiverGuard

Liver Disease Detection System



### 1. Data Augmentation :

Random noise injection and SMOTE interpolation

### 2. Data preprocessing :

Skin yellowness index calculation using RGB values and encoding categorical variables

### 3. Model Training :

Training base layer models (RF, SVM, LR, XGB and CatB) with hyperparameter tuning

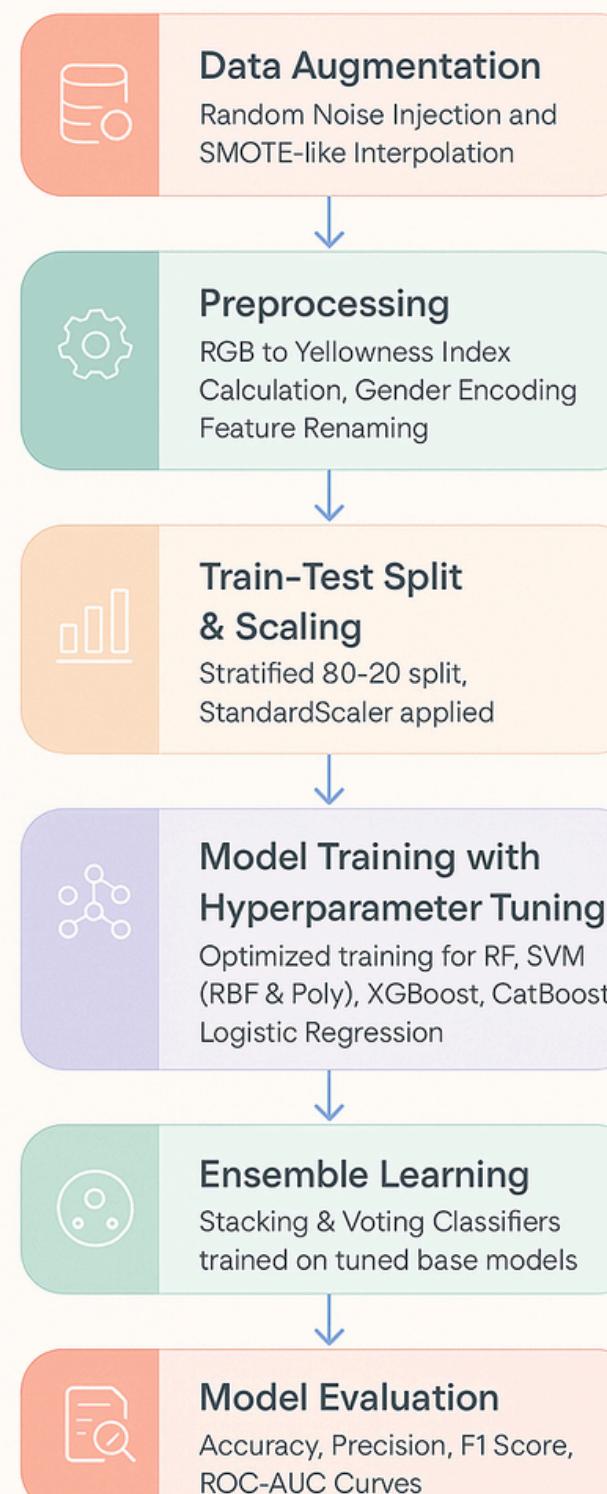
### 4. Ensemble Learning :

Stacking and soft voting on trained models

# ML ARCHITECTURE

## AI Architecture for LiverGuard

Liver Disease Detection System



## 5. Model evaluation :

Calculating Accuracy, Precision, F1, ROC-AUC

## 6. Explainability :

Feature importance graphs

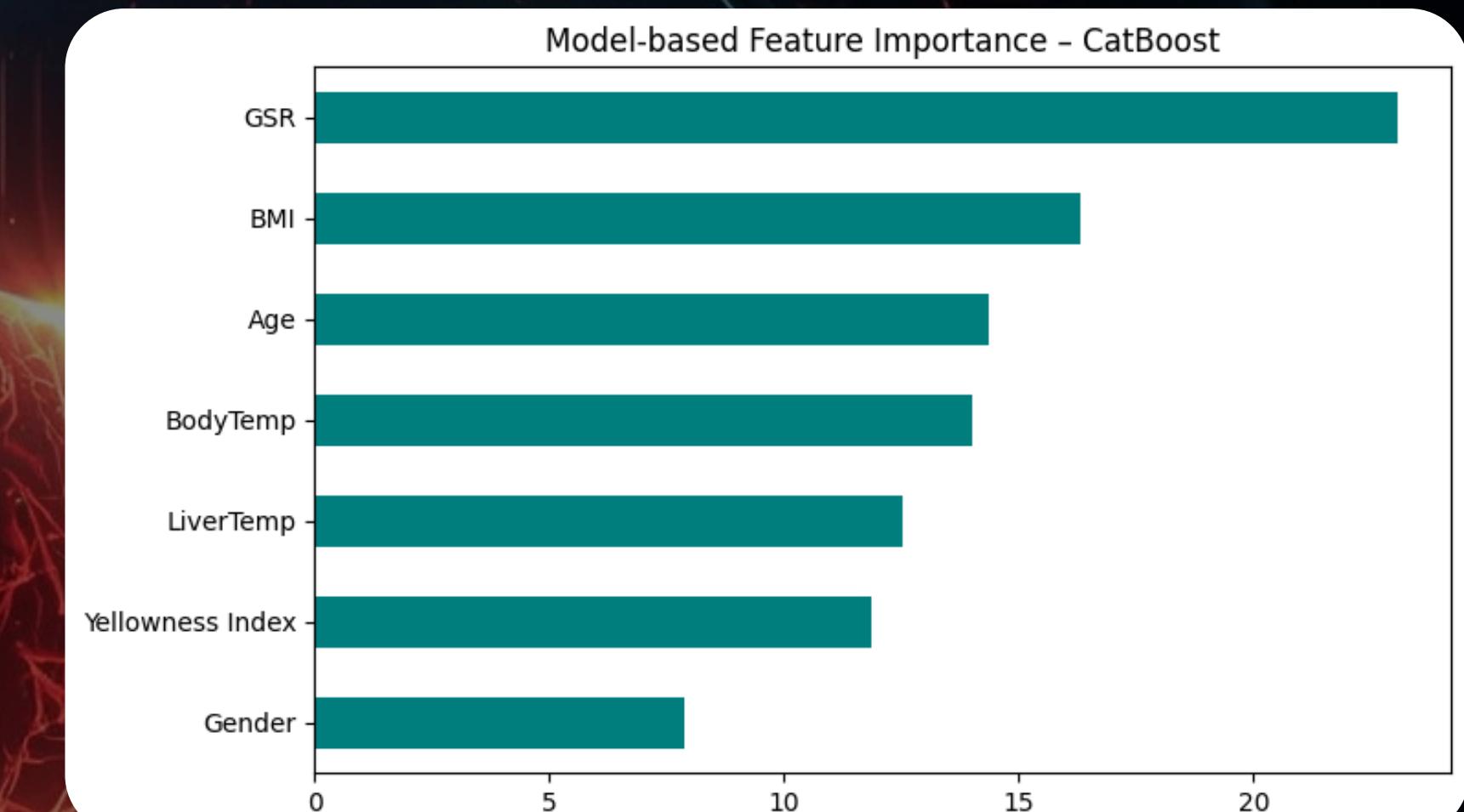
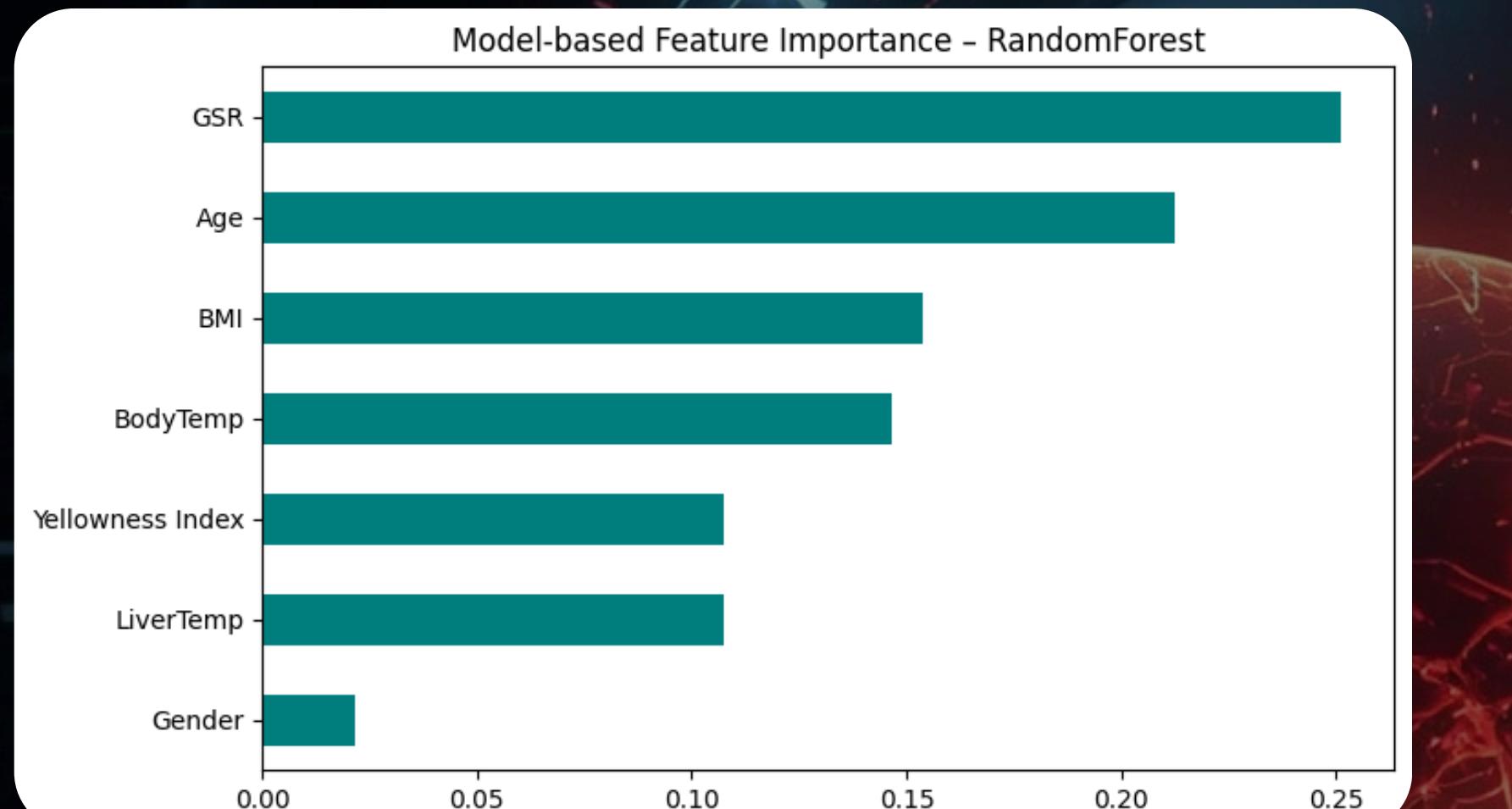
## 7. On-time inference :

User input → Preprocess → Predict :  
Healthy / Unhealthy

## 8. Model dumping :

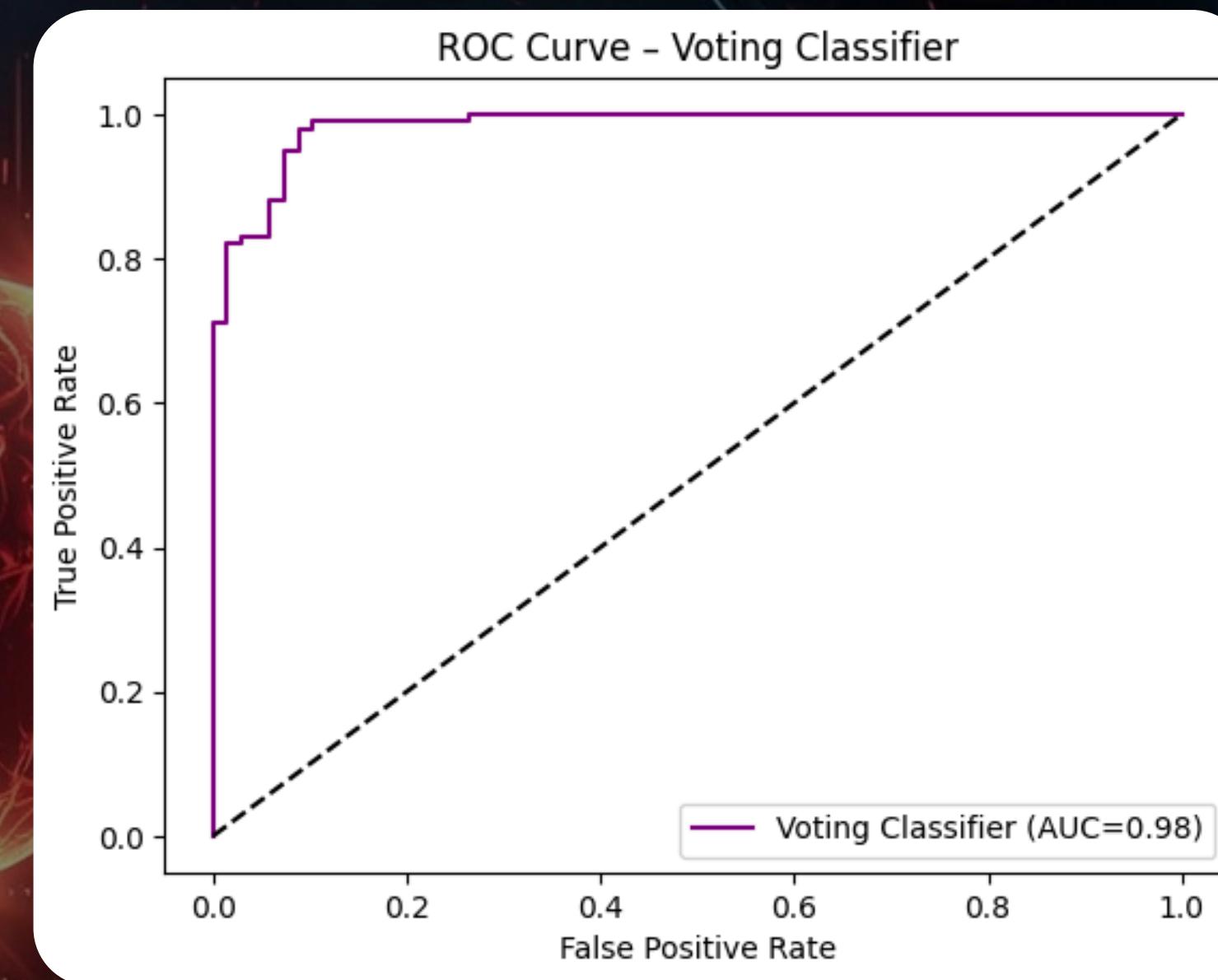
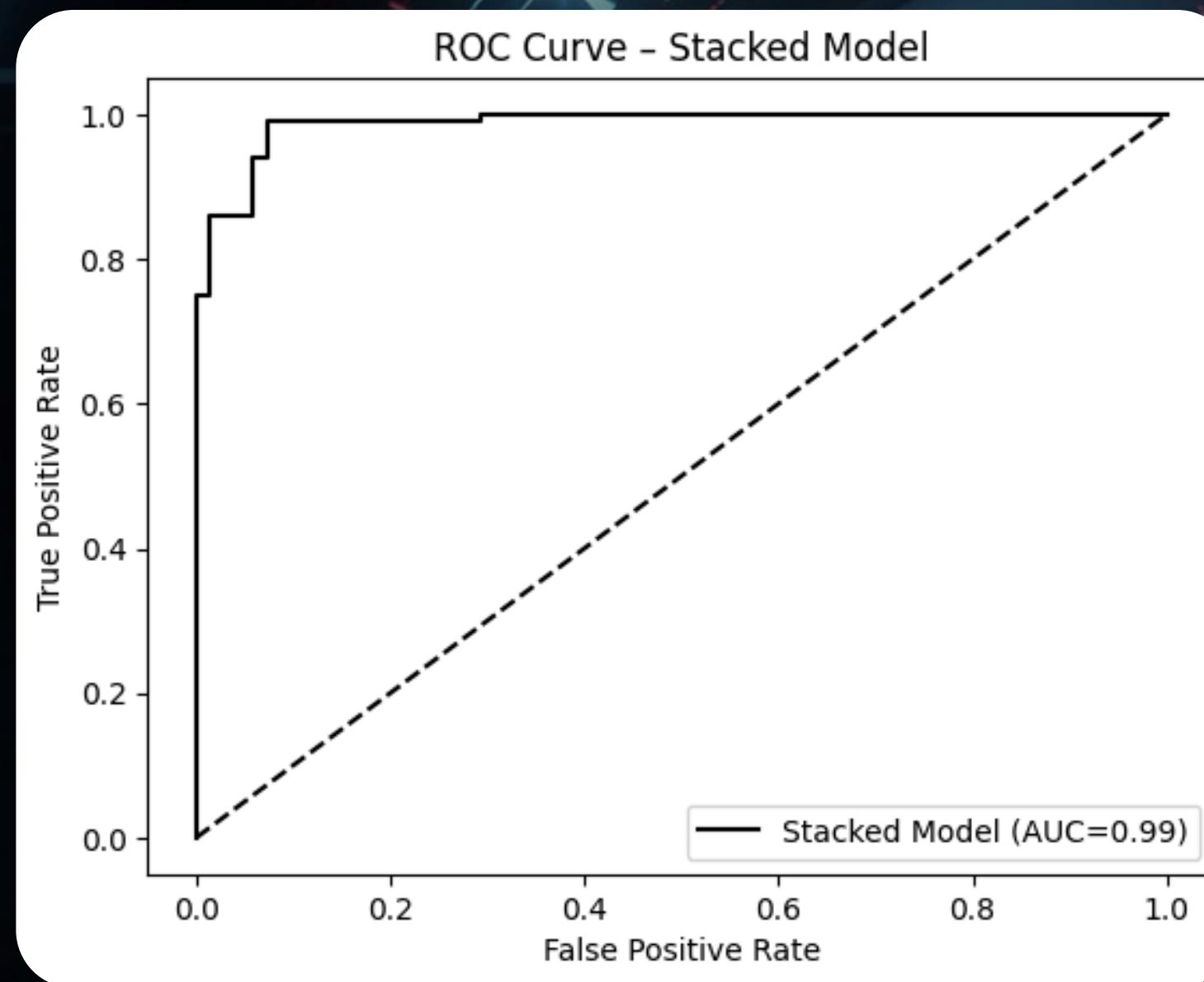
Exporting stacking and soft voting models as pickle files

# FEATURE IMPORTANCE



- 1. GSR value is the top predictor of liver health.
- 2. Age, BMI, and Body Temperature are strong secondary indicators.
- 3. Gender affects liver health the least.

# RESULTS



**Accuracy : 95%**  
**ROC-AUC Score : 0.987**  
**F1 Score : 0.93 (Unhealthy) and 0.96 (Healthy)**  
**Precision : 0.94 (Unhealthy) and 0.95 (Healthy)**

**Accuracy : 95%**  
**ROC-AUC Score : 0.983**  
**F1 Score : 0.94 (Unhealthy) and 0.96 (Healthy)**  
**Precision : 0.98 (Unhealthy) and 0.93 (Healthy)**

# REFERENCES

- [1]Li, N., Jiang, Y., Gong, G., Han, G. and Ma, J., 2018. Non-invasive assessment model of liver disease severity by serum markers using cloud computing and internet of things. *IEEE Access*, 6, pp.33969-33976.
- [2]Swain, S., Mohanty, M.N. and Pattanayak, B.K., 2024, November. Precision medicine in hepatology: harnessing IoT and machine learning for personalized liver disease stage prediction. In *Int J Reconfigurable & Embedded Syst* ISSN (Vol. 2089, No. 4864, p. 4864).
- [3]Guo, J., Bu, R., Shen, W. and Feng, T., 2025. Towards robust multimodal ultrasound classification for liver tumor diagnosis: A generative approach to modality missingness. *Computer Methods and Programs in Biomedicine*, 265, p.108759.
- [4]Li, T., Guo, J., Tao, W., Bu, R. and Feng, T., 2025. MUCM-FLLs: Multimodal ultrasound-based classification model for focal liver lesions. *Biomedical Signal Processing and Control*, 107, p.107864.



**THANK  
YOU**