Melanoma Recognition through Dermoscopic Imaging and SVM Classification

Sulekha Kundu

Department of Computer Science and Engineering,
Calcutta Institute of Technology
Banitabla, Uluberia, Howrah – 711316, West Bengal, India
Email: *sulekhakundu81[at]gmail.com*
ORCID- 0009-0000-2193-4740

Abstract: ***In today's modern world, skin cancer is one of the most common causes of death among humans. It is an abnormal growth of skin cells, often developing on areas exposed to sunlight, but it can also occur on parts not directly exposed. Fortunately, most skin cancers are curable if detected early. Therefore, early and fast detection can be life-saving. Traditional diagnosis methods, such as biopsy, involve removing skin tissue for laboratory testing. Though effective, these are painful, time-consuming, and costly. To address these issues, we propose a Skin Cancer Detection System using Support Vector Machine (SVM) for early and non-invasive diagnosis. The system leverages image processing techniques and SVM algorithms to improve detection speed and accuracy. Importantly, it also reduces unnecessary excisions of harmless moles and lesions through precise classification. The Skin Cancer Detection System is an innovative healthcare solution aimed at supporting early diagnosis, particularly of melanoma, the most dangerous form of skin cancer. By utilizing machine learning algorithms and advanced image processing, this system analyzes digital images of skin lesions and classifies them as benign or malignant. It is designed to provide a user-friendly and reliable platform for healthcare professionals, dermatologists, and individuals for proactive skin health monitoring.***

Keywords: skin cancer detection, SVM classification, image processing, melanoma diagnosis, medical imaging

1. Literature Review

Traditional Methods of Skin Cancer Detection

Skin cancer can be classified into:

- **Basal Cell Carcinoma (BCC)**
- **Squamous Cell Carcinoma (SCC)**
- **Melanoma** (most dangerous)

The **ABCDE Rule** is a common clinical method for visual assessment:

- **A**symmetry
- **B**order irregularity
- **C**olor variation
- **D**iameter > 6mm
- **E**volution over time

However, such methods are subjective and time-consuming, potentially leading to misdiagnosis.

Image-Based Detection Systems

With the rise of high-resolution imaging, automated detection systems now rely on **dermatoscopic images**, which offer more detail than standard photography.

Machine Learning Approaches

Machine learning, especially **Convolutional Neural Networks (CNNs)**, has significantly improved skin cancer classification accuracy. A notable study by **Esteva et al. (2017)** achieved dermatologist-level performance using a dataset of over 100,000 images.

Datasets for Skin Cancer Detection

- **ISIC (International Skin Imaging Collaboration):** Thousands of annotated dermoscopic images.
- **HAM10000:** A large public dataset widely used for supervised and unsupervised learning.

Challenges

- **Class imbalance:** Benign cases far outnumber malignant ones, causing bias.
- **Image variability:** Lighting, resolution, and angle inconsistencies demand strong preprocessing.

Key Features

- **AI-Powered Diagnosis:** Uses CNN and SVM for high-accuracy classification.
- **Real-Time Image Processing:** Users receive immediate feedback on lesion risk.
- **User-Friendly Interface:** Accessible via mobile and web platforms.
- **Diagnostic Assistance:** Aids healthcare professionals in decision-making.
- **Data Analytics:** Tracks trends and provides long-term health insights.
- **Reporting & Alerts:** Generates detailed risk assessments and recommended actions.
- **Educational Resources:** Includes skincare guidelines and early warning signs.

Target Audience

- **General Public:** Especially individuals with a family history or high sun exposure.
- **Healthcare Providers:** Dermatologists and clinicians for faster screening support.
- **Insurance Companies:** For preventive healthcare cost reduction.
- **Research Institutions:** For studies in AI, image processing, and healthcare innovation.

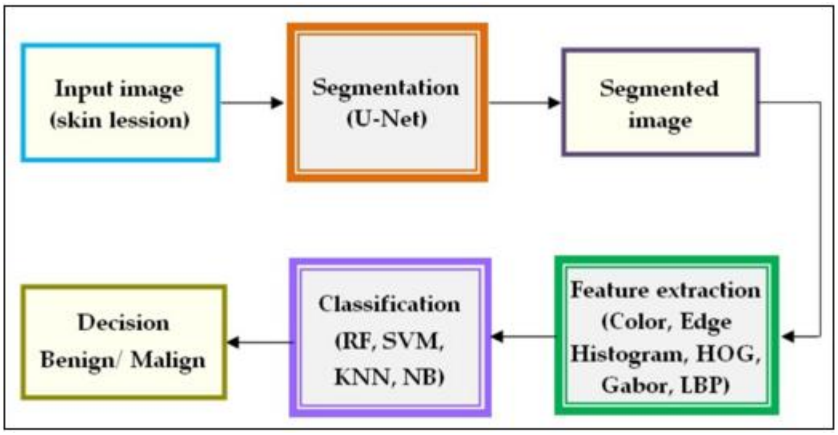


Figure 1

2. Methodology

Image Processing & Classification

The detection process involves identifying cancerous patterns in skin lesion images using the following methods:

- **GLCM (Gray Level Co-occurrence Matrix):** Extracts texture-based features from dermoscopic images.
- **SVM (Support Vector Machine):** A powerful classifier used for distinguishing between benign and malignant lesions.

Implementation:

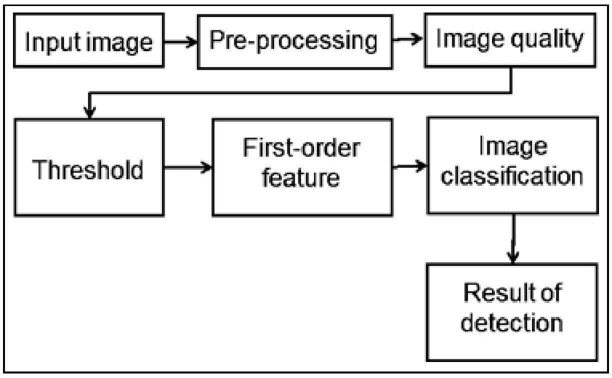
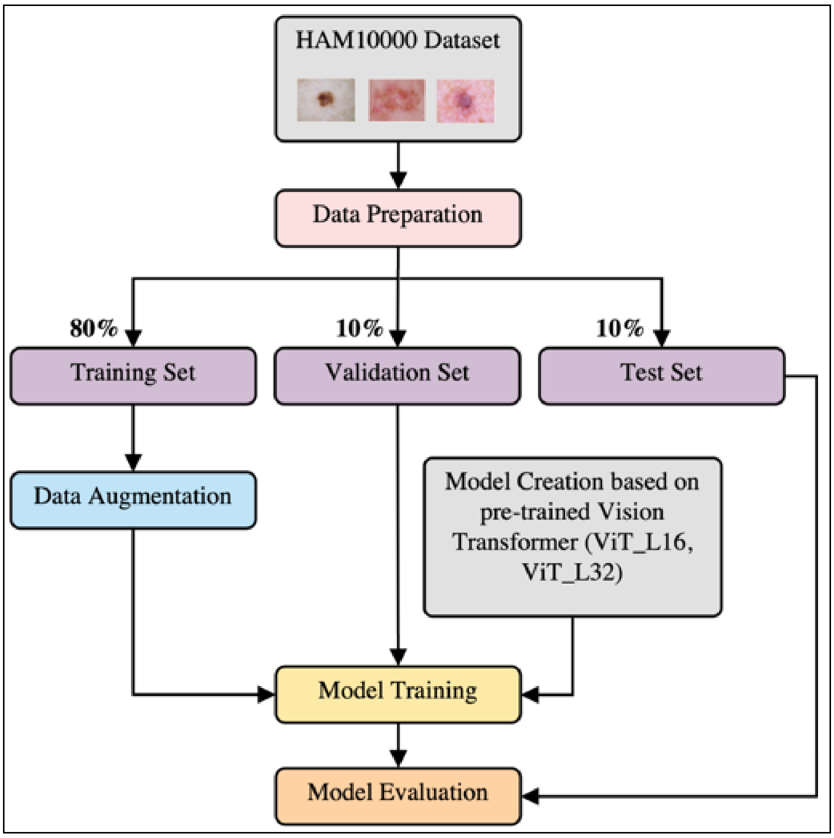


Figure 2

Image Processing Techniques

- **Watershed segmentation**
- **Edge detection**
- **Morphological operations**



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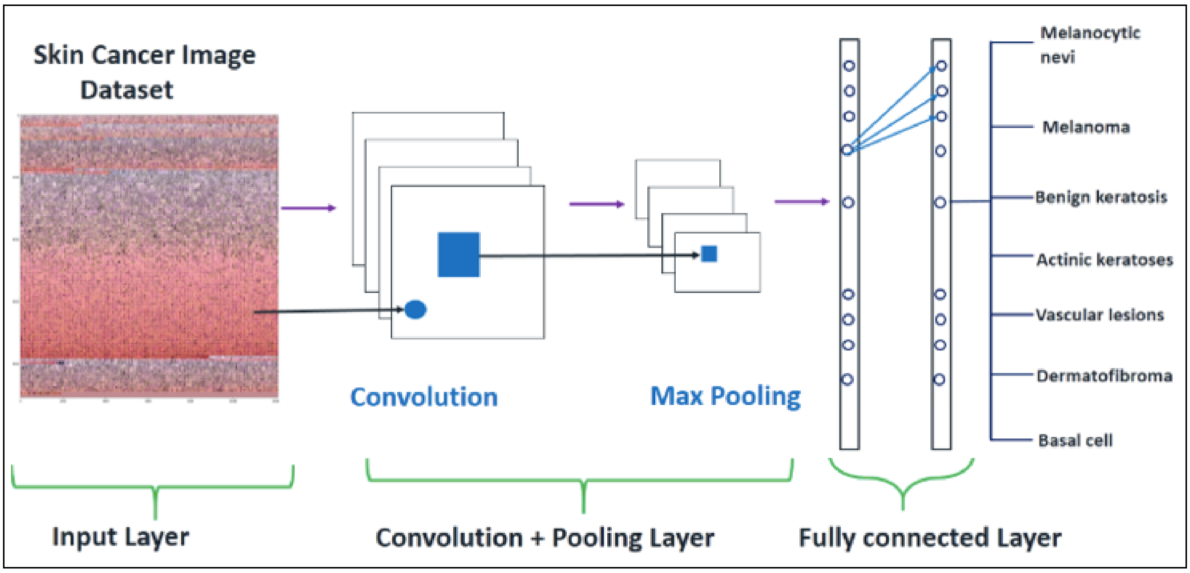


Figure 4

Step No.	Process Block	Description
1	Input Image	Image of the skin lesion is given as input.
2	Pre-processing	Enhances the image for better analysis (e.g., noise removal, contrast adjustment).
3	Image Quality	Image quality assessment or improvement based on preprocessing.
4	Threshold	Segmentation of the image to isolate lesion regions.
5	First-order Feature	Extraction of statistical features like mean, variance, etc.
6	Image Classification	Classification of lesion using extracted features (e.g., SVM, CNN).
7	Result of Detection	Final output indicating whether the lesion is benign or malignant.

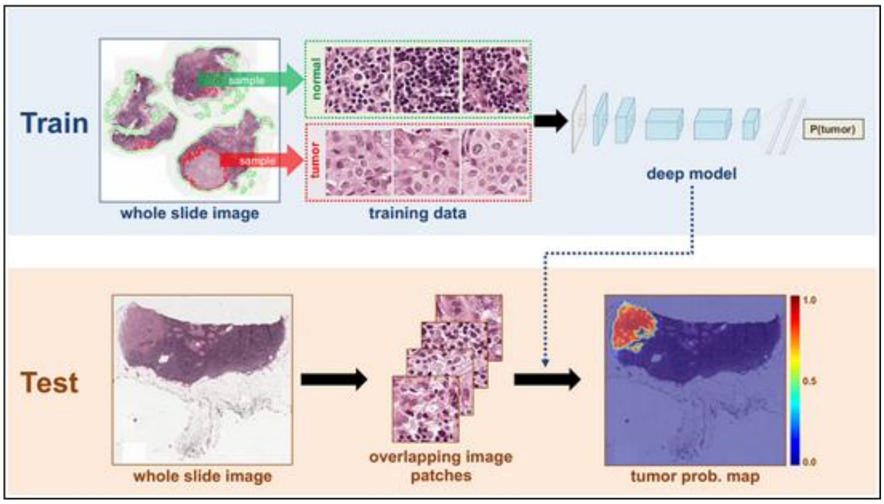


Figure 5

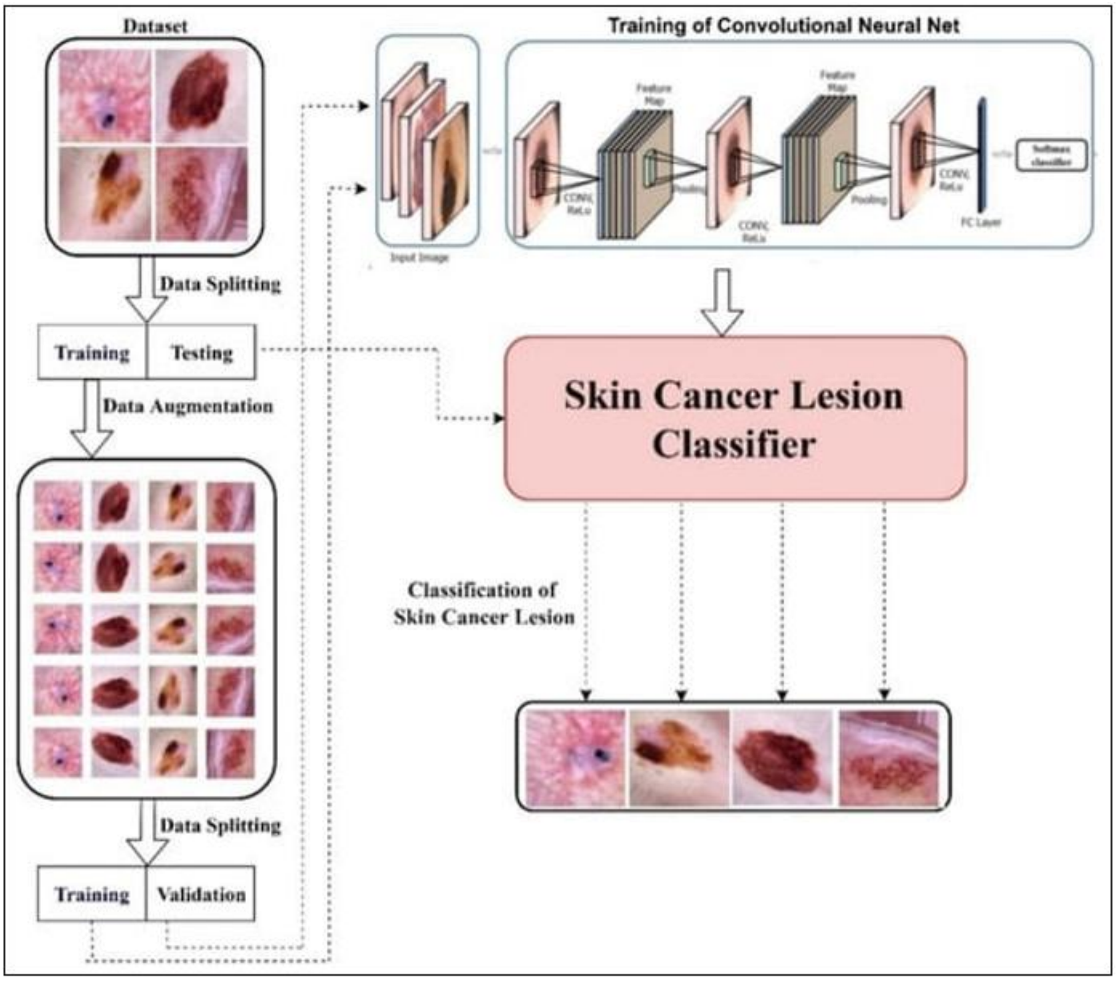


Figure 6

Accuracy Calculation
Each training iteration processes a **batch of images** through the **CNN layers**:
- Convolutional Layers
- Pooling Layers
- Fully Connected Layers

The model then makes **predictions**, which are compared against actual labels.

Loss Calculation
The **Binary Cross-Entropy Loss** function measures the difference between predicted and actual labels (benign or malignant).

Epochs and Batches
- One **epoch** = one full pass through the training dataset.
- Data is divided into **batches**.
- Weights are updated after each batch.
- Validation set performance is checked after each epoch.

Learning Rate
- Controls the **step size** for weight updates.
- Too high: Overshoots the optimal solution.
- Too low: Slow convergence.
- Often adjusted **dynamically** using **learning rate schedules**.

Early Stopping
Training is **stopped early** if validation loss doesn't improve for a set number of epochs. The **best-performing model** on the validation set is saved.

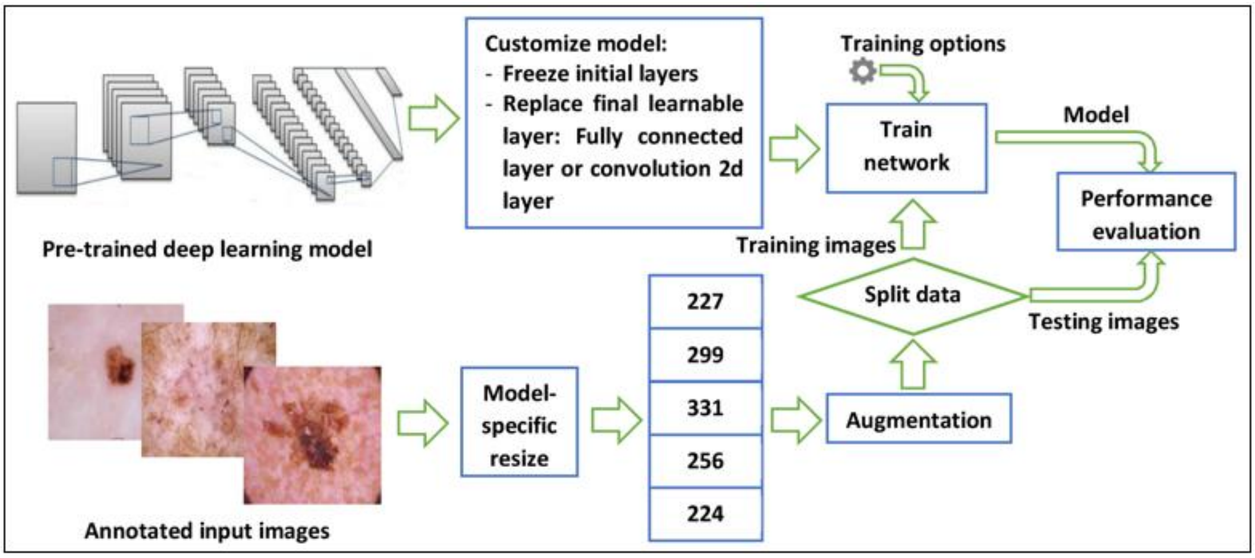
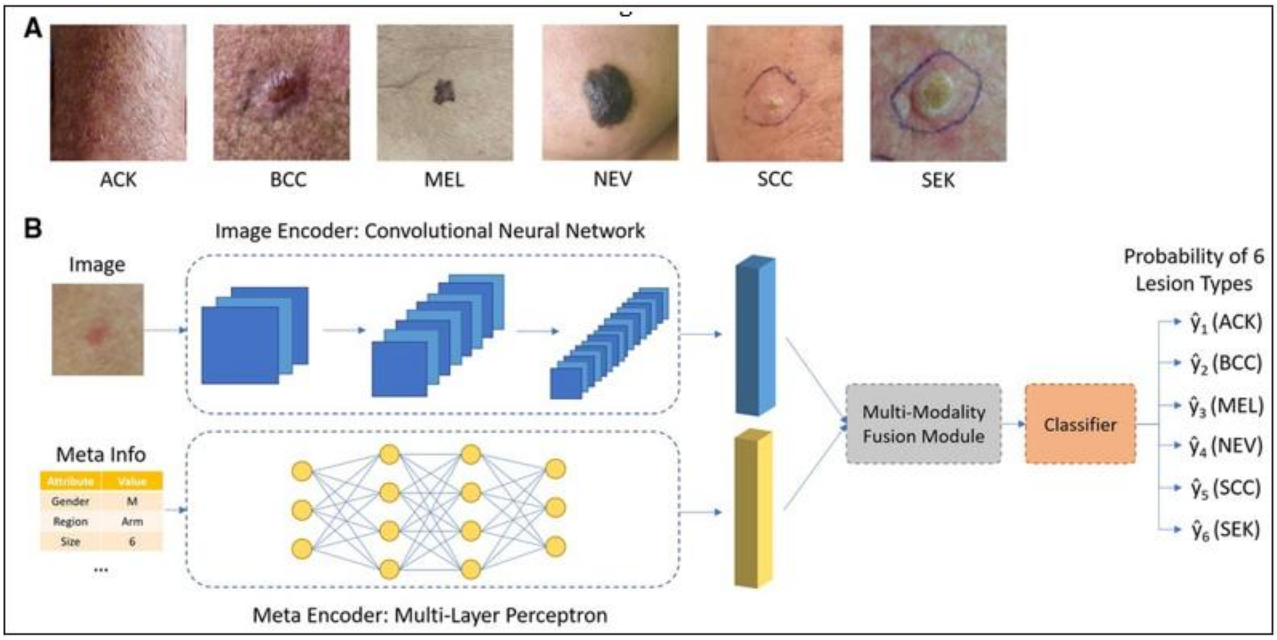


Figure 3



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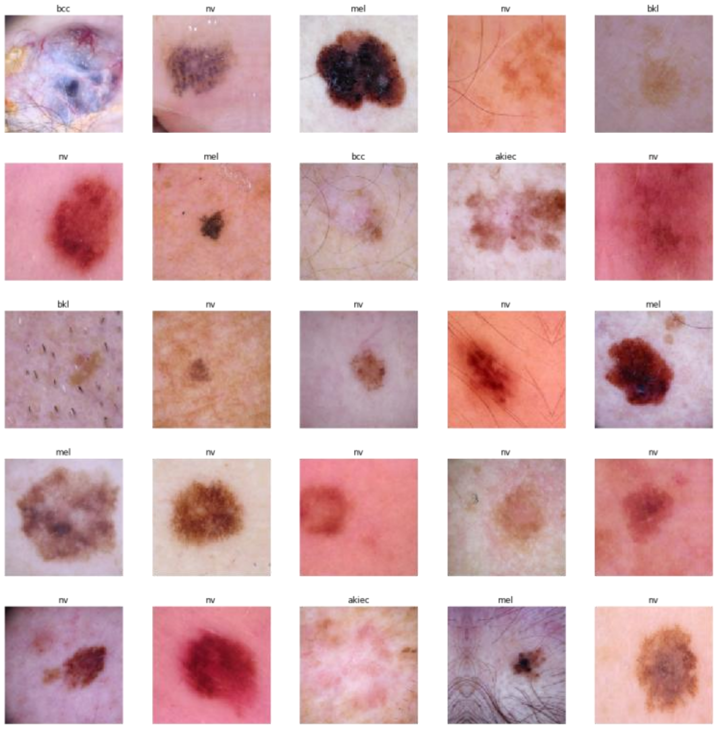

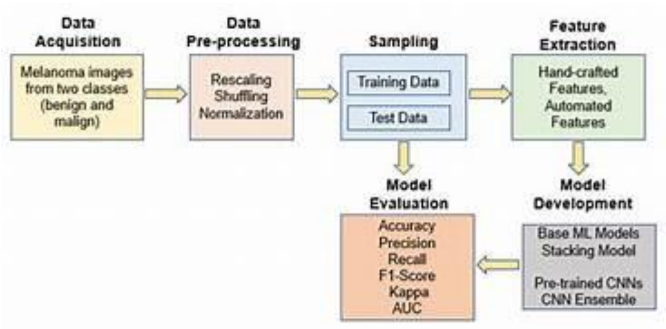

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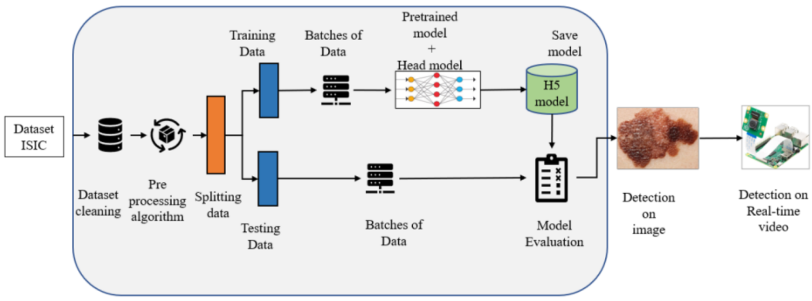
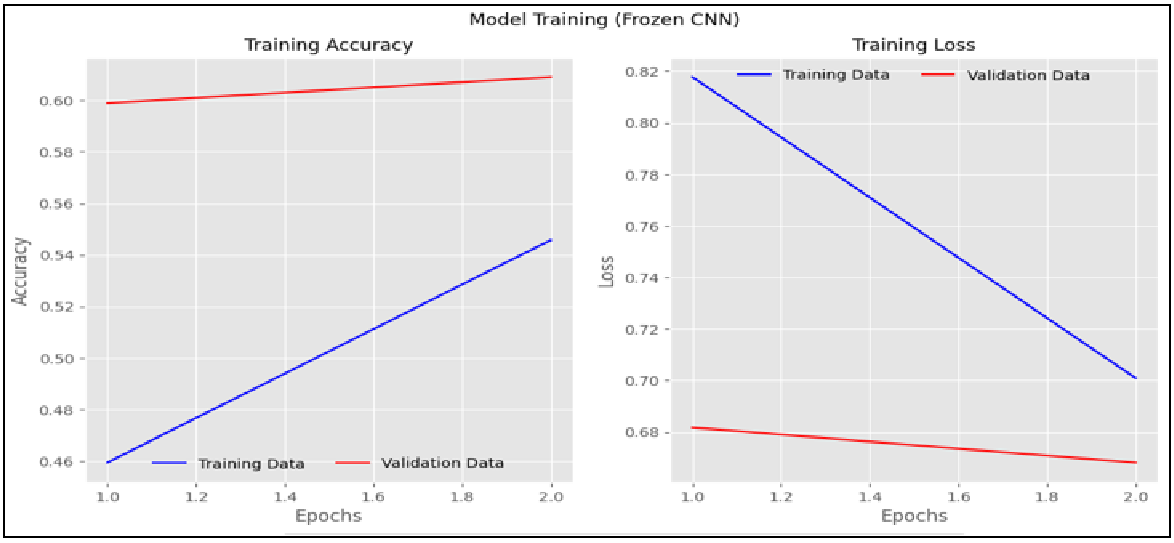
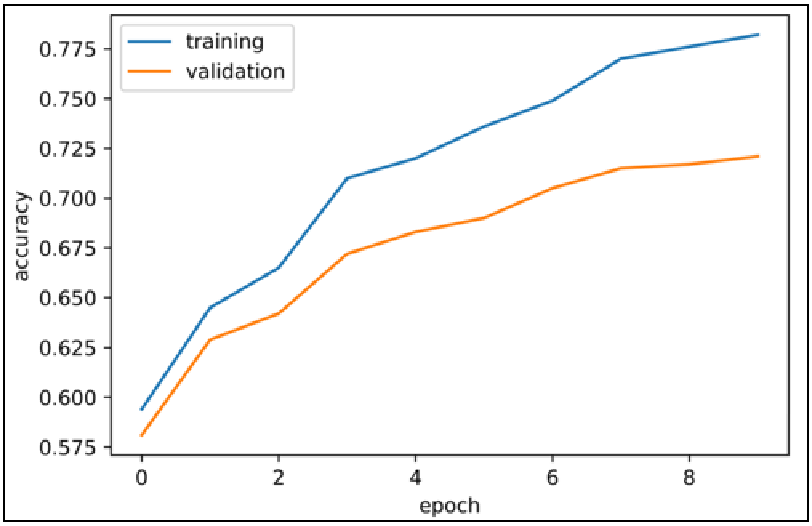


Figure 6

Model Training:





3. Benefits

- **Early Detection and Prevention:** Improves early detection rates, leading to better outcomes and a higher chance of successful treatment.
- **Cost-Effective:** Reduces the need for unnecessary visits to healthcare providers by offering a preliminary diagnostic tool to determine if a visit is warranted.
- **Convenience:** Accessible on mobile devices and desktops, allowing users to check their skin health anytime, anywhere.
- **Data-Driven Insights:** Provides valuable data for healthcare providers to track the evolution of skin lesions over time, enabling better-informed clinical decisions.
- **Educational Value:** Empowers individuals with the knowledge to monitor and maintain skin health, reducing the risk of late-stage diagnosis.

4. Future Enhancements

a) **Larger and More Diverse Datasets:** Expanding the dataset to include a broader range of demographics (age, ethnicity, gender) will help the model generalize more effectively across different populations and skin types. Incorporating images captured under varied lighting conditions and with different imaging devices can reduce biases related to image quality.

b) **Classification of Multiple Skin Cancer Types:** Moving beyond the binary classification of benign vs. malignant lesions, the system can be enhanced to identify and classify multiple types of skin cancer, providing more specific diagnostic information.

c) **Electronic Health Records (EHR) Integration:** Integrating patient history- such as family history of skin cancer, previous diagnoses, and treatment records—with image data could improve predictive accuracy. Combining clinical and image-based features through advanced machine learning models will enable more holistic diagnoses.

d) **Simultaneous Multi-Task Learning:** Implementing multi-task learning approaches could enable the system to perform multiple diagnostic tasks simultaneously, such as:
   - Identifying lesion boundaries
   - Predicting malignant cell presence
   - Estimating risk based on lesion texture, size, and shape

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