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# IoT Based -Skincare Assistant

**Subjects : Introduction to NN, CNN and GNN (24AIM113)**
**Analog system design (24AIM114)**


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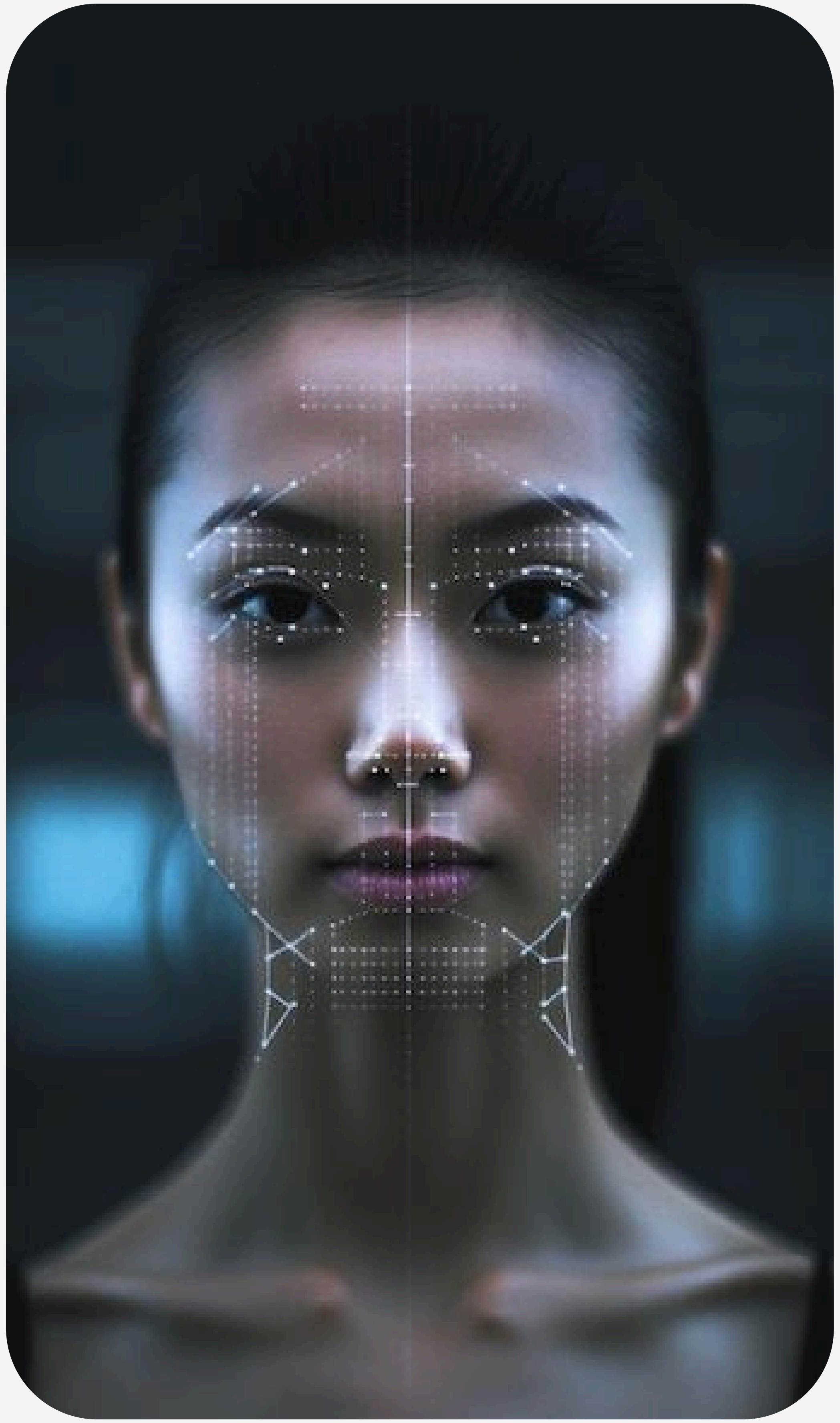


# Introduction

Skin health is essential for overall well-being and is influenced by factors like moisture, oil balance, UV exposure, and acne. Our project integrates hardware sensors namely TCS3200, moisture sensor, DHT11, UV sensor with deep learning models like CNN & Neural Networks to analyze skin conditions and provide personalized skincare recommendations, including morning and night routines, product suggestions, lifestyle changes, ensuring an effective and data-driven skincare approach.

# Literature Review

| Serial No. | Title | Techniques | Key Contributions |
|---|---|---|---|
| 1 | Personalized Skincare Product Recommendation System Using Content-Based Machine Learning | Content-based machine learning | Uses skin type, ingredient preferences to recommend skincare products; focuses on user-specific data. |
| 2 | Skincare Recommender System Using Neural Collaborative Filtering with Implicit Rating | Neural collaborative filtering, implicit feedback | Uses implicit ratings for personalized skincare recommendations; improves prediction accuracy using neural networks. |

| Serial No. | Title | Techniques | Key Contributions |
|---|---|---|---|
| 3 | Detection of Skin RGB Color with a Battery-Free NFC Skincare Device | Battery-free NFC, RGB color detection | Proposes a portable, energy-efficient device for skin color analysis, ideal for integration into skincare apps. |
| 4 | AC-Skin: Facial Acne Detection-Based on Intelligent Learning and Large Data Collection of IoT for Smart Skincare | Intelligent learning, large dataset collection, IoT | Leverages IoT data and machine learning to detect acne for personalized skincare solutions. |
| 5 | New Directions for Skincare Monitoring: An NFC-Based Battery-Free Approach Combined with Deep Learning Techniques | NFC technology, deep learning | Combines NFC and deep learning for sustainable skincare monitoring, providing real-time analysis. |

# Research Gaps

Limited Personalization – Current systems lack real-time sensor-based skincare recommendations.

AI-IoT Integration – Few studies combine IoT-based skin monitoring with AI-driven skincare analysis.

Holistic Deep Learning Models – Deep learning is underutilized in skincare.

Real-Time Monitoring – Skincare systems rarely provide adaptive, continuous tracking

# Problem Statement

Skincare recommendations are often generalized and fail to consider individual skin conditions, environmental factors, and real-time skin data. Existing systems lack integration of AI, IoT-based monitoring, and deep learning for precise skincare analysis. There is a need for a holistic, personalized skincare recommendation system that analyzes oil levels, moisture, UV exposure, and acne severity using sensors and image processing. Our project addresses this by developing an AI-driven system that provides tailored skincare suggestions.

# Workflow

**01**

Sensors collect real-time skin and environmental data. An image of the user's skin is captured for acne detection.

**02**

Sensor data is normalized, and image preprocessing is applied for CNN analysis.

**03**

CNN detects acne severity, while a neural network processes sensor data to generate personalized skincare recommendations.

**04**

Outputs a customized morning and night skincare routine, product suggestions, and lifestyle/diet changes.

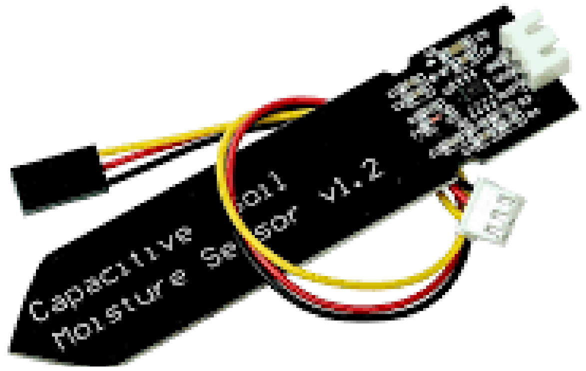
# Hardware components

**ESP32 Microcontroller**
Works on WiFi/Bluetooth.
Collects sensor data, processes it, and transmits results.

**TCS3200**
Detects RGB intensity. Uses photodiodes to analyze reflected light, converting it into a frequency-based output.

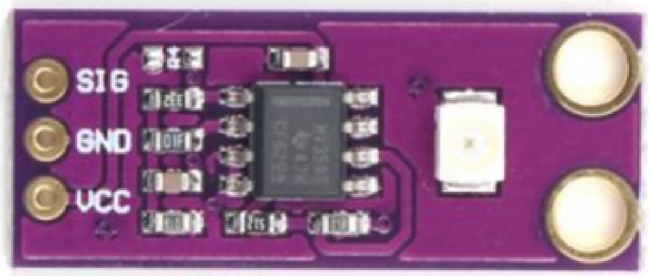
# Hardware components

**Capacitive Moisture Sensor**
Gives an analog output for moisture level detection.
Measures capacitance changes due to moisture variation..




**DHT11 Sensor**
Measures humidity using a capacitive humidity sensor
and a thermistor to provide digital readings.

**GUVA-S12SD UV Sensor**
Used for UV detection, has a UV-sensitive photodiode to measure
radiation and analog output.

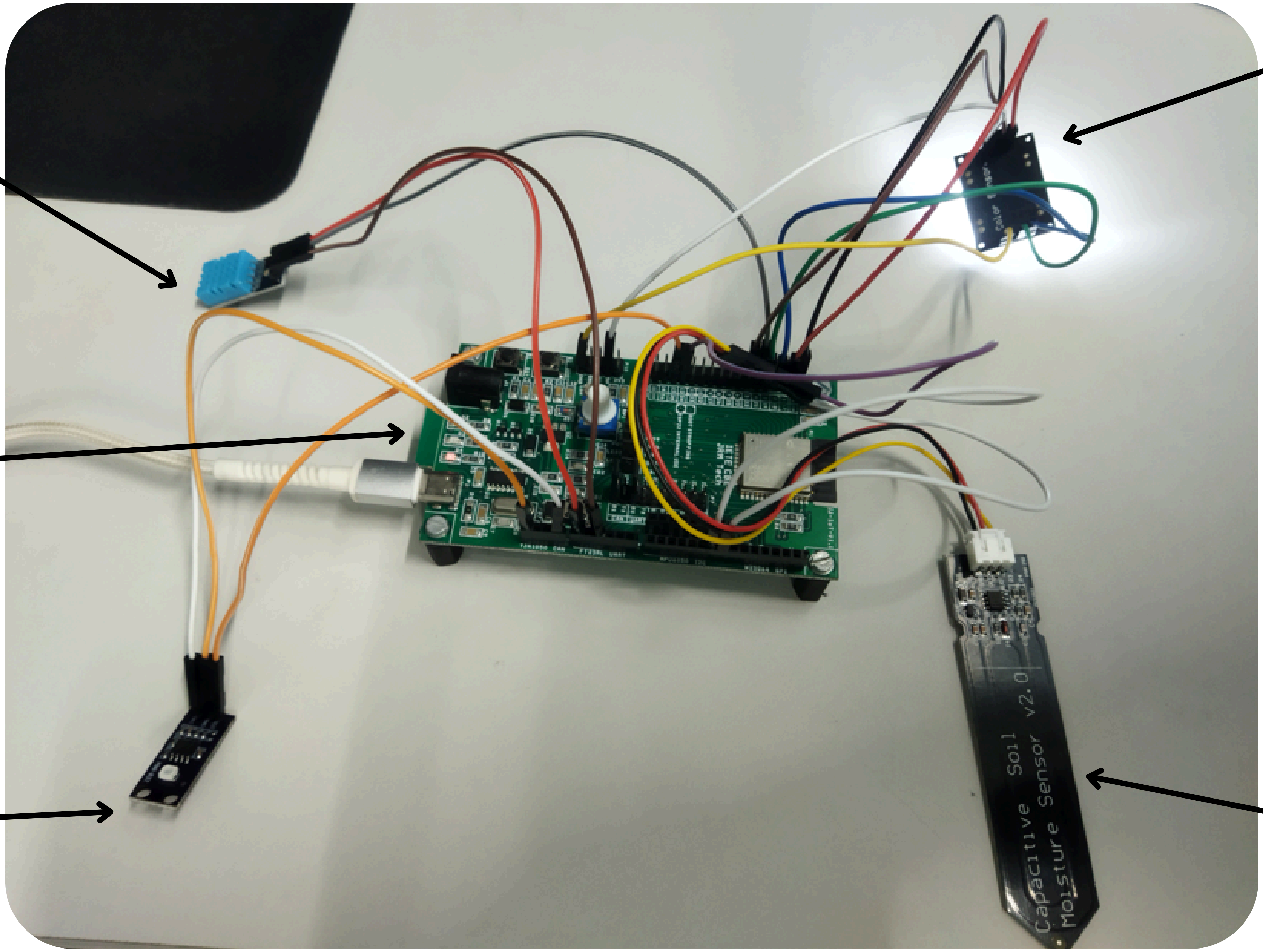


# System design

DHT11

ESP32

GUVA-S12SD UV Sensor




TCS3200

Capacitive Moisture sensor

# Feed forward Neural Network for Skincare Recommendations

**Neural networks** process sensor data (oil, moisture, UV exposure) for personalized **skincare recommendations**.

**Feedforward Neural Network (FNN)** is good at handling structured data like moisture, oil, and UV levels. FNN efficiently maps input features to skincare recommendations without needing spatial awareness, making it computationally lighter than CNNs.

**Pre Processing Steps :**

- **One-Hot Encoding** – Converts categorical sensor data (moisture, oil, UV, etc.) into numerical values.
- **Adding Noise** – Introduces slight noise in features and labels to make the model robust.
- **Feature Scaling** – Uses StandardScaler() to normalize the features to a standard range.

# Model Architecture

1. **Input Layer** (Fully Connected) - Takes the processed input features and passes them to the hidden layer.
2. **Hidden Layer** (Fully Connected - Dense) (64 neurons) - Learns patterns from the input features using weighted connections.
3. **ReLU Activation** (reluLayer)
4. **Dropout Layer** - It randomly deactivates 20% of the neurons during training and thus prevents overfitting of the model. This improves generalization.
5. **Output Layer** (Fully Connected - Dense) - Converts features into class probabilities for final classification.
6. **Softmax layer** - converts raw outputs into probabilities between 0 to 1. The final prediction is the class with highest probability. This ensures model outputs interpretable probability values.
7. **Epochs** - 50
8. **Batch Size** - 32
9. **Loss Function** - Cross-Entropy Loss
10. **Accuracy** - 0.90

# Model Architecture

**Why ReLU activation function in hidden layers ?**

If the input is positive, it will keep it as it is, if the input is negative, it will set it to zero. ReLU also keeps gradients large enough for deep networks and avoids vanishing gradient.

**Why Softmax in output layer ?**

- Converts raw outputs (logits) into probabilities for multi-class classification.
- Ensures that output probabilities sum to 1, making interpretation easier.

**Why Cross-Entropy Loss?**

Cross-entropy loss is used for classification problems to measure how well the predicted probabilities match the actual labels.

- Helps the model learn faster by focusing on incorrect predictions.
- Works well when outputs are probabilities (like softmax).

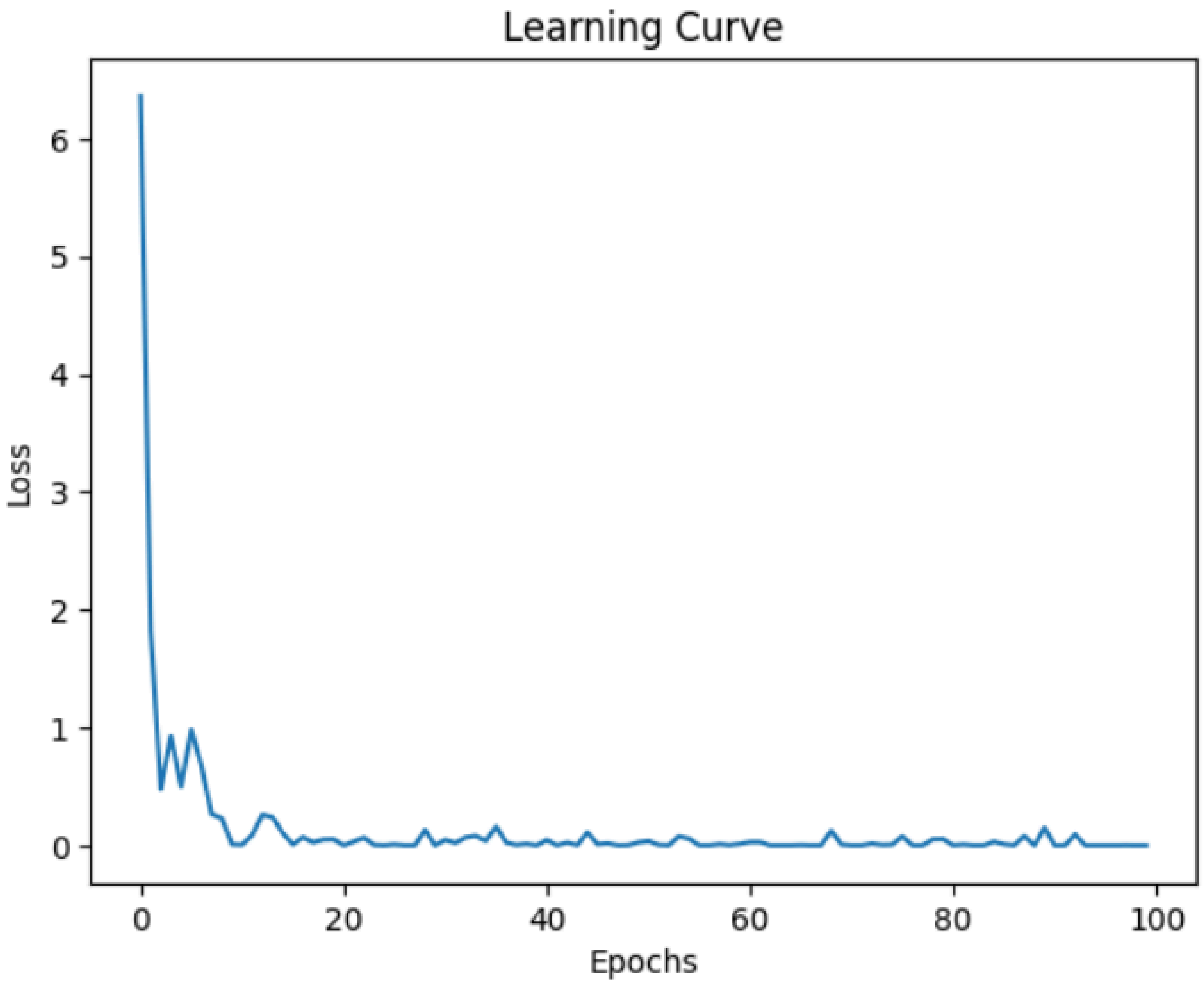
# CNN for Acne Detection

Deep learning enables accurate skin analysis by extracting features from images and sensor data. **Convolutional Neural Networks (CNNs)** are used for **acne detection** and classification.
CNN is chosen for image-based acne level detection due to its strong feature extraction capabilities.

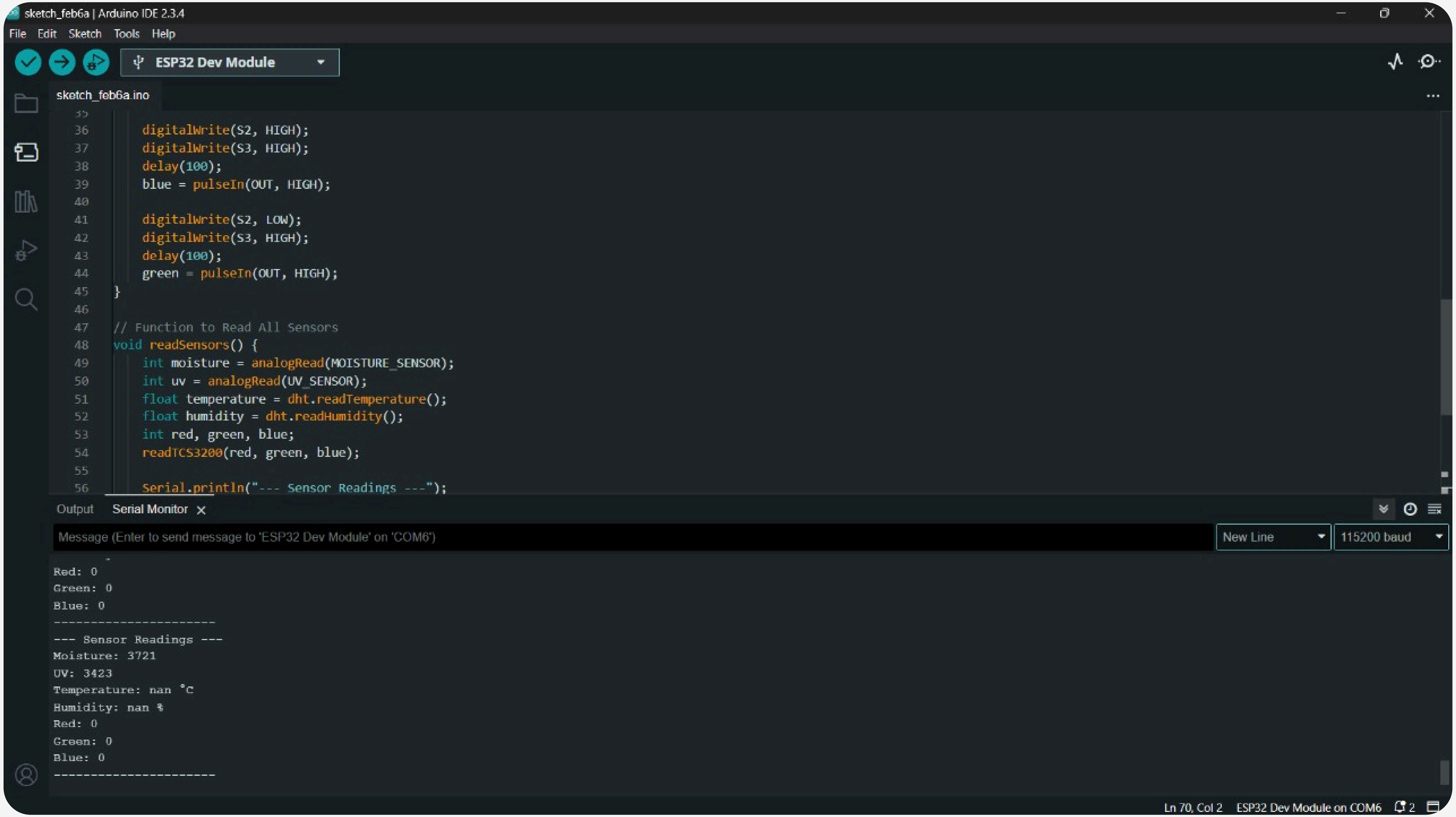
We are using CNN for acne detection because it excels at **image analysis**, identifying features like pimples while preserving spatial relationships. CNNs are ideal for acne classification due to their strong feature extraction.

# Learning curve

A learning curve is a graph that shows how a machine learning model improves over time during training.



# Code snippet



# Expected output

```
--- Sensor Readings ---
Moisture Level: Medium
Oil Level: High
UV Exposure: High
Temperature: 30°C
Humidity: 55%
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--- Skin Type & Analysis ---
Skin Type: Oily Skin

--- Morning Skincare Routine ---
1. Cleanse: Use a gentle foaming cleanser with salicylic acid.
2. Tone: Apply an alcohol-free toner to balance oil
production.
3. Moisturize: Use a lightweight, oil-free moisturizer.
4. Sun Protection: Apply a broad-spectrum sunscreen (SPF
50).

--- Night Skincare Routine ---
1. Cleanse: Use a mild gel-based cleanser to remove excess
oil.
2. Exfoliate: Use a BHA-based exfoliant (2-3 times per
week).
3. Treat: Apply a niacinamide serum to control oil and acne.
4. Moisturize: Use a water-based, non-comedogenic
moisturizer.

--- Recommendations ---
- Choose non-comedogenic, oil-free skincare products.
- Use blotting paper or a clay mask to absorb excess oil.
- Drink plenty of water and maintain a balanced diet.
- Avoid over-washing, as it may trigger more oil production.
- Protect your skin from UV rays by reapplying sunscreen
every 2-3 hours.
- Reduce dairy and high-glycemic foods to minimize
breakouts.
```

# Timeline

**Week 1**

Sensor Integration Completed

**Week 2**

Data Collection- Gather sensor readings from multiple users (moisture, oil, UV levels, environmental data)

**Week 3**

Collect skin images for acne detection, preprocessing & training the model

**Week 4**

Neural Network Implementation for Skincare Recommendations

**Week 5**

System Integration: Combine sensor data, CNN model, and recommendation system

**Week 6**

Testing & Optimization: Improve model accuracy, debug errors, refine skincare suggestions

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# Datasets

**Acne dataset :** https://www.kaggle.com/datasets/nayanchaure/acne-dataset

**Skincare recommendation dataset :** https://www.kaggle.com/code/melissamonfared/skincare-products-eda-sentiment-analysis

# Thankyou