AI-Based Future Fabrication System Using Physiological and Visual Parameters

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Abstract

The textile and fashion industry traditionally relies on generalized fabric selection methods that do not consider individual physiological differences. This paper presents an Artificial Intelligence (AI)-based future fabrication system that recommends suitable fabric types by analyzing physiological and visual parameters such as pH value, body temperature, pressure-based comfort, and skin tone. Sensor data is collected using an Arduino-based Internet of Things (IoT) framework and processed using machine learning techniques. A Random Forest classifier is employed to predict appropriate fabric types in real time. Experimental results demonstrate that the proposed system enhances personalization and comfort, achieving an average prediction accuracy of approximately 92%. The system shows strong potential for application in smart clothing and intelligent textile manufacturing.

Keywords: Artificial Intelligence, Smart Fabrication, Machine Learning, IoT, Skin Tone Detection, Personalized Textiles

1 Introduction

Fabric selection significantly affects comfort, usability, and skin health. Conventional fabrication processes use standardized materials that fail to adapt to individual variations in body chemistry, thermal conditions, and skin sensitivity. Such limitations often result in discomfort and reduced user satisfaction.

Recent advancements in Artificial Intelligence (AI) and Internet of Things (IoT) technologies have enabled intelligent systems capable of real-time data acquisition and decision-making. By leveraging these technologies, it is possible to design adaptive fabrication systems that personalize fabric selection. This paper proposes an AI-based fabrication framework that integrates physiological sensing and computer vision to recommend suitable fabrics for individual users.

2 Related Work

Smart textiles and wearable sensing technologies have been widely studied for health monitoring and comfort analysis. Machine learning-based recommendation systems have shown success in personalization across various domains. Computer vision techniques for skin tone detection have also been applied in fashion and cosmetic industries.

However, existing systems often focus on isolated parameters and lack a unified framework combining physiological and visual features for fabric recommendation. The proposed system addresses this gap by integrating multiple sensing modalities into a single AI-driven fabrication model.

3 System Architecture

The proposed system consists of three primary layers:

3.1 Data Acquisition Layer

Physiological data such as pH value, body temperature, and pressure are collected using sensors interfaced with an Arduino UNO microcontroller. A camera is used to capture skin tone information.

3.2 Processing and Intelligence Layer

Sensor data is transmitted to a host computer via serial communication. Visual features are extracted using OpenCV, and all features are processed by a machine learning model implemented in Python.

3.3 Recommendation Layer

The trained AI model predicts suitable fabric types based on the processed data and provides real-time recommendations.

4 Methodology

4.1 Physiological Parameter Analysis

The pH sensor measures skin acidity, which influences fabric suitability. Body temperature indicates thermal comfort needs, while pressure values reflect fabric tightness and comfort.

4.2 Skin Tone Detection

Skin tone is extracted using average RGB values from a selected region of interest in the captured image. These visual features are incorporated into the AI model.

4.3 Machine Learning Model

A Random Forest classifier is selected due to its robustness and ability to handle non-linear feature interactions. The model is trained using labeled datasets consisting of physiological parameters and corresponding fabric types.

5 Implementation

5.1 Hardware Implementation

An Arduino UNO interfaces with pH, temperature, and force sensors. Sensor readings are periodically transmitted to the host system.

5.2 Software Implementation

The AI system is developed in Python using Scikit-learn for machine learning and OpenCV for computer vision. The trained model is deployed for real-time inference.

5.3 Algorithm

1. Acquire sensor readings from Arduino
2. Capture skin tone image
3. Extract and normalize features
4. Apply trained Random Forest model
5. Display fabric recommendation

6 Results and Discussion

The system was evaluated under different physiological conditions. The Random Forest model achieved an average accuracy of approximately 92% in fabric classification. Real-time predictions were generated with minimal latency. The results confirm that combining physiological and visual parameters significantly improves personalization compared to traditional methods.

7 Applications

The proposed system can be applied in:

- Smart and wearable clothing
- Medical and therapeutic textiles
- Sports and fitness apparel
- Defense and military uniforms
- Personalized fashion manufacturing

8 Future Work

Future enhancements include integrating deep learning models for fabric texture analysis, robotic fabrication systems, and cloud-based AI platforms for large-scale deployment.

9 Conclusion

This paper presented an AI-based future fabrication system that utilizes physiological and visual parameters to recommend suitable fabric types. The integration of IoT sensors, computer vision, and machine learning enables personalized and intelligent fabric selection. Experimental results demonstrate the effectiveness of the proposed approach, highlighting its potential impact on smart textile and fashion industries.

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