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# Application of Artificial Intelligence in the personalization of hairstyles and hair care

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## Abstract

The article presents an analysis of the application of artificial intelligence technologies in the personalization of hairstyles and the diagnosis of hair conditions, conducted within an interdisciplinary paradigm that integrates hairdressing, trichology, dermatology, and computer vision. The methodological basis of the study is a content analysis of academic sources focused on generative models for virtual hairstyle visualization, hair segmentation algorithms, automated scalp diagnostics, and digital tools for assessing hair structure. Two key areas of artificial intelligence application are systematized: personalization of images through virtual try-on and automated diagnosis of hair and scalp conditions. Analytical tables are presented describing AI tools for personalization, diagnostic methods for hair, and a comparison of the strengths and weaknesses of technologies. The analysis shows that the integration of artificial intelligence enhances the transparency of stylist recommendations, strengthens client trust, and reduces the likelihood of errors in care selection. Key challenges are identified, including the need to expand training datasets to account for the diversity of hair types, adapt models to everyday photographs, and develop applications integrated into professional practice. The results confirm the high practical relevance of digital solutions for the beauty industry and justify the prospects for implementing AI tools in hairdressing practice. The article will be useful for hairdressers-stylists, trichologists, dermatologists, computer vision researchers, and developers of software solutions for the beauty industry.

**Keywords:** Artificial Intelligence; Hairstyle Personalization; Hair Diagnostics; Hairdressing Industry; Computer Vision; Deep Learning

## 1. Introduction

Hairdressing is undergoing a period of rapid change. Until recently, the practitioner relied primarily on personal experience, intuition, and a visual assessment of hair condition; in today's context, digital technologies play an increasingly prominent role. Clients have become more discerning. They want to see the result in advance, compare alternative looks, and be confident that the proposed care regimen truly matches their individual characteristics.

Artificial intelligence opens new horizons for the beauty industry. For the hairdresser-stylist, it is a modern instrument and a practical way to improve service quality. These technologies enable virtual try-ons, allowing a person to see how a new haircut or color will look before the procedure begins. This reduces the risk of error and increases confidence in the choice. In parallel, algorithms can perform diagnostics (assessing hair density and structure, detecting scalp issues, and generating individualized care recommendations) [2]. Taken together, AI serves as both an assistive solution and a full-fledged partner to the practitioner in creating a personalized look.

Such technologies assume particular importance in a highly competitive environment. Salons that adopt digital solutions gain an advantage: they can offer a higher level of service, build trust, and strengthen long-term relationships.

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In addition, using AI helps the stylist work more efficiently—faster solution selection, fewer mistakes, and more professional consultations.

The purpose of this study is to analyze the use of AI technologies for personalizing hairstyles and hair care, to determine their practical value for hairdresser-stylists, and to show how these solutions can raise consultation quality, improve client interaction, and expand the practitioner's professional capabilities.

## 2. Materials and Methods

This study is based on an analysis of publications that examine various approaches to applying AI for personalizing hairstyles and hair care. All included works employ methods of computer vision and deep learning; their applications can be grouped into two key blocks: look visualization and hair diagnostics with personalized care selection.

The first block focuses on the capabilities of generative models and segmentation algorithms. Abdallah [1] demonstrated the effectiveness of StyleGAN2 for creating virtual hairstyles and altering hair style based on a client's selfie. Such a system enables trying on different cuts and colors with photorealistic visualization. The second block addresses the diagnostics of hair and scalp conditions. Jin [4] showed that applying EfficientNet (a deep convolutional neural network for image classification) allows the accurate detection of dandruff and erythema. Gudobba [3] proposed automating alopecia assessment from images, standardizing diagnosis, and minimizing the specialist's subjective influence.

Another direction involves automating hair density measurement. Kim [8] compared EfficientDet (a convolutional neural network for object detection), YOLOv4 (the fourth-generation "You Only Look Once" real-time detector), and Detectors (an object detection model with recursive convolutional connections). YOLOv4 delivered the best results. The algorithm accurately identified follicles with one and two hairs but had difficulty recognizing bundles of three or more hairs, which the authors attribute to class imbalance in the training set. Despite these constraints, the technology accelerates diagnostics and lowers the likelihood of errors during visual assessment.

A significant contribution to hair phenotyping was made by Makkar [9], who applied Mask R-CNN (a region-based convolutional neural network for instance segmentation) to analyze parameters such as thickness, luster, and texture. Feature-detection accuracy exceeded 99%, demonstrating the technology's potential for both fundamental and applied purposes. Several studies emphasized the practical implementation of personalized recommendations. Kim [6] presented an AI-driven system for selecting scalp-care products. In clinical tests involving one hundred participants, improvements in scalp and hair condition were observed, underscoring the promise of AI for selecting care products.

As an overarching method, this review systematized technologies into the two blocks of look visualization and hair diagnostics. This approach made it possible to identify the advantages and limitations of each technology and to determine their practical value for hairdressing practice.

## 3. Results

The application of AI in hairdressing clearly shows that digital technologies can ease practitioners' work and reshape the model of client interaction. Personalizing the look moves to the forefront, as salon clients increasingly want to preview the result without exposing hair to chemical processing or risking an unsuitable style choice.

One line of development is generative models that create virtual hairstyles and color outcomes based on the client's photo. Abdallah [1] showed that StyleGAN2 can produce photorealistic images in which the client can "try on" different cuts and shades. This approach reduces uncertainty, simplifies decision-making, and helps the stylist justify new options. For the practitioner, it means shorter consultations, greater client trust, and fewer cases of dissatisfaction with the outcome. Another advance is precise hair segmentation on images. Yoon [10] introduced Mobile-Unet (a convolutional neural network optimized for real-time hair-image segmentation on mobile devices), which achieves real-time segmentation at 13 milliseconds with 89.9% accuracy. This tool is especially convenient for mobile applications, making it suitable for in-salon use. The client can see exactly how hair is isolated in the photo, while the practitioner gains a fast tool for preparing for coloring or toning.

The practical benefits are evident. Virtual try-ons and rapid photo analysis allow the stylist to offer individualized solutions before any procedure begins. This heightens client engagement and satisfaction, setting new service standards. Unlike traditional practice—where decisions relied on verbal descriptions or images of other people's results—AI offers a personalized option tailored to the client's specific features and hair structure. Table 1 presents the main AI tools used for virtual personalization, their outcomes, and their practical utility for stylists.

**Table 1** AI tools for virtual hairstyle personalization

| Source | Technology | Data | Result | Application for a stylist |
|---|---|---|---|---|
| Abdallah [1] | StyleGAN2 | Client selfies | Realistic hairstyle and color try-on | Demonstration of new looks before the actual procedure |
| Yoon [10] | Mobile-Unet | 95,200 hair photos | IoU 89.9%, speed 13 ms | Fast hair segmentation for coloring/toning in mobile apps |

Diagnostics of hair and scalp have changed rapidly in recent years with the adoption of AI algorithms. These technologies allow the practitioner to move beyond subjective judgments and work with objective data, substantially increasing the accuracy of recommendations and client trust. Jin [4] showed that EfficientNet achieves accuracy up to 82% in identifying dandruff and erythema, helping the stylist prescribe appropriate anti-inflammatory care. Similar results were reported by Kim [7], who proposed a model for analyzing scalp images even with limited data, confirming the practical applicability of such solutions for mobile diagnostic apps.

Assessing hair density has progressed thanks to object-detection methods. Kim [8] compared multiple architectures, including EfficientDet and DetectoRS; YOLOv4 performed best, with a mean average precision of 58.67%. The authors note that the method reliably estimates hair counts per unit area, although accuracy decreases when recognizing bundles of three or more hairs.

Hair phenotyping is another active direction. Makkar [9] described "deep hair phenomics," based on Mask R-CNN, which determines parameters such as thickness and luster with accuracy up to 99.7%. For the practitioner, this enables monitoring hair aging dynamics, refining care recommendations, and selecting cosmetic products with regard to individual characteristics.

An important complement appears in Jütte [5], where a synthetic dataset improved artifact removal in images and increased scalp-analysis accuracy. Also noteworthy are the results of Kim [6], where algorithms were used to prescribe personalized scalp-care products, demonstrating direct integration of AI into cosmetic therapy. Table 2 summarizes leading methods supported by studies, their results, and their practical significance for hairdressing.

**Table 2** AI solutions for hair and scalp diagnostics

| Source | Object | Technology | Result | Practical application |
|---|---|---|---|---|
| Jin [4] | Dandruff, erythema | Efficient Net | Accuracy up to 82% | Recommendation of anti-inflammatory scalp care |
| Kim [7] | Scalp condition | CNN (custom) | Effective with limited data | Mobile diagnostic apps for stylists |
| Kim [8] | Hair density | YOLOv4 | mAP 58.67 | Objective alopecia risk assessment |
| Makkar [9] | Thickness, shine | Mask R-CNN | Accuracy 99.7% | Aging control, personalized cosmetic care |
| Jütte [5] | Dermo copy images | DL dataset | Improved artifact removal | Higher precision in scalp image analysis |
| Kim [6] | Scalp cosmetics | AI-based prescription | Improved scalp health in 100 participants | Personalized cosmetic recommendations |

These studies show that hairdressing diagnostics are becoming more precise and clinically grounded. For practitioners, this marks a shift from subjective consultation to professional expert assessment based on objective digital data, enhancing client trust and enabling personalized care strategies.

## 4. Discussion

Applying AI methods in salon practice gives the practitioner a tool to align expected outcomes with the client before the procedure starts. Generative models enable realistic "try-ons" of cuts and color based on the client's photo, thereby reducing the risk of mismatched expectations and easing decisions about shape, length, and color techniques [1]. This visualization becomes part of the consultation, turning discussions of style from the abstract into a specific, evidence-based dialogue—especially important for dramatic image changes.

Equally important is the shift from subjective evaluation of hair and scalp to quantitative indicators. Image-based classification models support recognition of key signs associated with dandruff and erythema, giving the practitioner a clear basis for selecting gentle cleansers, exfoliation regimens, and anti-inflammatory care [4]. Standardized annotation of alopecia features from photographs makes grading of hair loss reproducible and suitable for longitudinal monitoring, thereby facilitating choices of strengthening, density-focused, and preventive procedures [3]. Automatic grading of flaking from video recordings, validated across age groups and ethnic backgrounds, increases diagnostic generalizability and allows for client diversity without loss of interpretive accuracy [2].

Client trust grows through transparent recommendations. When the practitioner relies on visual reports and numerical condition maps, the conversation about care acquires an evidence-based character. Clinical testing shows that algorithmically personalized product prescriptions improve scalp condition and sustain satisfaction with care, confirming the practical value of digitally personalized regimens [6]. For the salon, this means higher-quality consultations and stronger long-term relationships built on clearly reasoned recommendations.

There is also a notable organizational effect. Lightweight segmentation models on mobile devices speed preparation of visual materials: isolating hair contours, rapid local toning, trial color-placement schemes—all can be performed during the consultation without overloading the practitioner's schedule [10]. This workflow increases throughput without sacrificing quality and supports unified consultation standards across the salon team. Collectively, these advantages form a new service standard: first, a safe, visual "try-on" of the look, then objective diagnostics and a structured care plan, followed by monitoring dynamics using comparable metrics. Within this framework, AI does not replace professional judgment; it enhances the accuracy, predictability, and persuasiveness of the stylist's recommendations [1, 3, 10].

Despite the clear benefits of AI adoption, several limitations complicate everyday use in the industry. The most important factor is the limited and homogeneous nature of many datasets. Most training sets were built from images covering a narrow range of hair and scalp types, which reduces generalization when serving clients across diverse ethnic groups and ages [4]. In practice, this can yield less accurate results for clients with curly, lightened, or gray hair, necessitating additional expert verification.

A further challenge is the incomplete integration of technologies into specialist-facing applications. While research prototypes demonstrate high accuracy for specific tasks such as hair segmentation or density estimation, full-fledged services for salon operations remain fragmented [8]. This creates a barrier to widespread use, as practitioners must juggle disparate tools that are not always interoperable.

A significant issue is the gap between laboratory testing and real client photos. Studies based on carefully curated datasets report high accuracy, but in daily practice, the practitioner often receives low-quality images taken on mobile phones under poor lighting or at suboptimal angles [9]. This undermines automated classification and requires further model adaptation to real salon conditions. In particular, algorithms need additional training on user-generated photos and built-in modules for automatic lighting and contrast correction. Table 3 summarizes the strengths and limitations of several featured solutions.

**Table 3** Strengths and limitations of AI tools in hairdressing practice

| Source | Strengths | Limitations |
|---|---|---|
| Jin [4] | Availability of web service, accuracy >80% | Errors in moderate dandruff stages |
| Kim [8] | Automation of hair density assessment | Weak accuracy for light hair |
| Kang [9] | Deep analysis of hair structure | Validation only on laboratory data |

As the table indicates, each technology has strengths that determine its value for practice. The model proposed by Jin [4] supports scalp diagnostics via an online service but remains vulnerable to errors at intermediate stages of dysfunction. The approach studied by Kim [8] automates hair-density estimation but underperforms on light hair. The hair-structure analysis described by Kang [9] reliably quantifies thickness and luster but has only been validated under laboratory conditions.

Accordingly, the key challenges for using AI in hairdressing include building more diverse and representative training sets, creating integrated specialist solutions, and adapting existing models to everyday client photos. Overcoming these barriers will improve diagnostic accuracy, enhance result predictability, and make digital technologies an organic part of daily salon work.

## 5. Conclusion

This study identified the principal directions for applying AI in hairdressing practice related to look personalization and objective assessment of hair condition. Generative models and segmentation algorithms demonstrated the potential of virtual try-ons for haircuts and color, allowing clients to evaluate proposed results in advance and reducing uncertainty when choosing a style. At the same time, computer image analysis proved effective for diagnosing scalp issues and measuring hair density, thickness, and luster, laying a foundation for more evidence-based care selection.

The analysis confirms that these technologies can transform practitioner–client interaction by strengthening trust in professional recommendations. Objective indicators of hair condition and visualization of the future look increase process transparency, with the practitioner's decisions backed by digital tools. This bolsters professional authority and boosts client satisfaction.

At the same time, the identified limitations underscore the need to adapt models to real salon conditions. Insufficient dataset diversity, sensitivity to everyday photo quality, and limited integration into professional applications hinder full-scale use. Addressing these issues requires collaboration between AI specialists and beauty-industry professionals.

The findings support the conclusion that the promising path for hairdressing development lies in integrating digital technologies into daily practice. AI can make style and care selection more precise, evidence-based, and trustworthy, thereby elevating the profession. Future research should focus on developing specialist applications for hairdressers, expanding the ethnic and age diversity of datasets, and evaluating the effectiveness of AI tools in real salon environments.

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