DEEP REVIEW ON ALOPECIA AREATA DIAGNOSIS FOR HAIR LOSS-RELATED AUTOIMMUNE DISORDER PROBLEM

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ABSTRACT

Lots of women all over the globe are affected by thinning hair, and the number of females suffering from the disease is growing per year. Another important component in the development of thinning hair is genetics. One of the most important goals is to make a clinical condition. For example, in the area of medicine, categorization is critical since one of the primary goals of the doctor is to determine whether or not a patient suffers from an illness. Alopecia areata is a kind of chronic illness that causes baldness in the affected region. AA may cause baldness for a variety of causes thus, testing may be essential to confirm if it is the source of the loss of hair. Machine learning approaches have shown promise in a variety of fields, including dermatology, and may be useful in identifying alopecia areata for better prediction and diagnosis. Proper detection of an illness is also influenced by the fluctuating character of illness signs. Deep learning algorithms for identifying hair loss levels in males using facial pictures in this research. In this situation, a special training database, including face photos with varying degrees of baldness, has been generated. Furthermore, despite the limited accessibility of hairs in such images, a matching approach for mechanically categorizing face images to design categorization tables of male baldness from the medical field is provided. The outcomes of the experiments demonstrate the potential and efficiency for medical, security, and business apps. Related work in machine learning for hair illness categorization has also been addressed. The main objective of this study to analyze several machine learning and deep learning strategies for the identification of alopecia as well as in humans, as well as to determine the accuracy of extracting features methodologies.

Keywords: Alopecia areata, Hair loss, Deep learning, Machine learning, Feature extraction approaches

INTRODUCTION

Among the many various kinds of alopecia Areata (AA), one of the most predominant is the abrupt onset of baldness in strongly defined areas, which may range from small spots to large or less usually broad involvement. Stress and incapacity may be exacerbated or masked by baldness, depending on its severity. Currently, the disorder is thought to be an inflammatory illness of the hair follicle with a hereditary component. There are around 0.1–0.2 % of the general population suffers from AA, which is an inflammatory illness of hair follicles [1].

AA is an autoimmune disorder that causes baldness without scarring. It may have a great effect on one's psychological health because of its visual effects. Follicle immunological privileged and a T-cell-mediated inflammatory reaction have been implicated in its pathophysiology, which results in the disruption of the hair development cycle. Numerous features may be seen in the form of well-defined spots, scattered or total scalp alopecia, or entire body hair alopecia. Some 40 % of people with alcoholism are at risk of having their condition return or becoming resistant to treatment [2]. AA is a harder illness that has a major effect on patients' standard of living because of its continuous relapse history [3]. An estimated 2% of the population suffers from the disorder known as alopecia areata, which is described by the initial inception of non-scarring hair defeat in specific regions. Only a tiny patch is affected by this condition in some people, whereas other individuals have more widespread or less regular diffused hair loss. The scalp, the beard region, and the eyebrows are the most prominent areas of hair loss [4].

Baldness is described as the "falling of substantial quantities of skull hairs" [5]. Alopecia areata is an inflammatory condition that causes non-scarring hair to fall in well-defined spots throughout the skull, eventually leading to baldness [6]. Lots of individuals worldwide are affected by the disease [7], particularly those with a hereditary background of alopecia areata [8]. It arises when the body's immunological structure begins to attack hair cells, disrupting their proper activity and limiting hair growth. Baldness is the result. Baldness may be caused by a variety of factors, and trichoscopy and biopsies are usually required to rule out alopecia areata. However, one of these diagnostics approaches' shortcomings is the lack of clarity about the series of experiments necessary for a proper evaluation. As a result, there is a lot of room for innovative methodologies in the categorization and evaluation of alopecia areata [9]. Baldness in visions is associated with a loss of power and control. Baldness dreams are often the result of a stressful event. Hair dreams, in the end, symbolize a circumstance that is beyond one's control. When hair is abruptly lost in waking life, the same sense of helplessness is felt [4].

ML approaches are successful in predicting and classifying a variety of illnesses and syndromes. Machine learning (ML) is the reading of various algorithms that can learn and adapt. In several medical fields, ML algorithms and their upgraded variations have been employed for diagnoses. ML algorithms, for example, have shown correctness in the identification of brain tumors, breast cancer, ovarian cancer, lung illness, and cutaneous disorders utilizing magnetic resonance imaging and computed tomography images. ML approaches have also been shown to be reliable during the COVID-19 pandemic, assisting doctors in recognizing the coronavirus illness and its levels [9]. For retrieving certain characteristics, variables, parameters, and object recognition from an image, computer vision studies employ numerous disciplines in vision machine learning research. Of course, when utilizing a properly prepared database and verified model, computer vision AI depends upon ML performs well; nonetheless, CNN-based AI still needs a large number of parameters. To solve this, studies are currently being undertaken which show great accuracy with small AI models, but it is believed that it will still have a problem fitting into solutions or light portable devices. Furthermore, to construct a model that performs exceptionally well in a certain area, the engineer needs a huge quantity of dataset for a pre-processed picture, which allows us to create a picture using the feature as input dataset via this task [10].

The literature study reveals that hair pictures have been used to identify alopecia areata in several studies (hair disorder). Dermoscopic and scalp pictures have been used in previous studies. To extract skin characteristics typical of alopecia areata, most investigations have employed scalp pictures.

Concept of alopecia areata

Baldness is referred to as alopecia as a whole. Any age may be affected by non-scarring hair loss caused by alopecia areata (hair loss that does not leave a mark on the skull). In most cases, it results in circular spots of baldness around the size of a coin on the skull, but it may also damage the hair on the beard, eyebrows, eyelashes, torso, and limbs. Some people may have damage to their complete scalp (alopecia totalis) or their complete body and scalp (alopecia universalis). It's impossible to know the quantity of hair you'll lose before the procedure. In ordinary alopecia areata, hair regrowth usually takes months or years, although it cannot be assured.

The more hair that is lost in the beginning, the higher the possibilities of regrowth. In a year, many persons with some tiny spots of hair loss have complete restoration. More than 50% of the hair is destroyed, and there is little hope of a full recovery. At least on the first occasion, the hair reverts to its original color. Most sufferers of alopecia areata have recurrences of the condition. Total restoration is less likely in cases of alopecia totalis or alopecia universalis [11, 12]. Fig. 1 shows
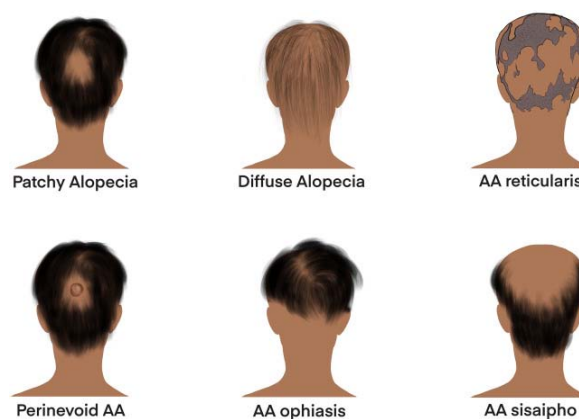
different types of Immunopathogenesis of Alopecia areata as an example of a low-resolution image.

A tingling feeling in the skull is possible. It may be a distressing condition, particularly if the baldness cannot be concealed by a haircut. If AA affects the eyelashes, dust can irritate the eyes, especially in dry and windy weather.

The following are some of the obtainable therapies:

Steroid creams and scalp applications

A short time is spent applying them to the bald patches, generally two times per a day. Local steroid injections: It is the most effective technique for minor spots of baldness and may be applied to the skull and eyebrows. Injections are given every 4-6 w until regrowth is accomplished, at which point they are halted. A little indentation can form at the injection's locations, although it normally fades away within a few months. When injecting the eyebrows, extra caution is required near the eyes, since too much might induce glaucoma (elevated burden inside the eyeball).

Fig. 1: Immunopathogenesis of Alopecia areata

Steroid tablets

Huge dosages of steroid pills can cause hair regrowth, although alopecia often reappears after the medication is stopped. Over time, taking steroids by mouth may produce a variety of negative effects, included high BP, stomach ulcers, cataracts, diabetes, weight gain, and osteoporosis.

Dithranol cream

The ointment that is often utilized to cure psoriasis, produces skin irritation and, on rare occasions, seems to encourage hair growth when applied to bald regions. Although there is just a little amount of proof for this, it is safe to use, therefore physicians can recommend it. Dithranol leaves a purple-brown stain on the skin and hair, which is especially noticeable in blonds and fair-haired persons.

Contact sensitization treatment

Such type of treatment comprises creating the patient sensitive to a substance (usually a chemical termed diphencyprone) and then smearing very tiny quantities of this chemical to affected patches for once in a week towards keep slight discomfort continuing. Itching, burning, and swollen glands in the neck are all potential side effects. Eczema may be prevalent in certain persons. Because it might cause skin discoloration (depigmentation), it should be taken with care in those with a dark complexion. This therapy is only offered at specialized facilities.

Ultraviolet light treatment (PUVA)

Such type of treatment entails taking a pill or using a lotion which after which exposing the bald areas to UV radiation 2 to 3 times a week for many months will make the skin light sensitive. When the medication is discontinued, alopecia recurs often. Skin malignancies are also a potential long-term concern.

Hair loss problem, factors and diagnosing

Hair is a thin-filaments that grows out of the skin as an extension. This member's lack of courage makes no sense. Each strand of hair is divided into divisions and layers. Natural hair color is the most distinguishing quality of hair, and it is a direct effect of race. The sizes of the hairs vary. Straight, wavy, and wavy hair may be categorized into 3 types based on their appearance [13]. Not only in various areas of the body but also in various sections of the head, the rate of hair development varies. Diverse hair colors and styles have a straight influence on the attractiveness of people's features. Natural hair loss ranges from 50 to 80 hairs each day. Hair loss may exceed this range in rare circumstances [14, 15]. Eventually, if hair loss develops to a severe degree, the scalp will be visible through the thinning hair. Bladder discomfort in both men and women follows a predictable pattern [16-18]. As a result, in males, the process began with the temples and crown and progressed from there. Women, on the other hand, have sporadic baldness. The hair's borders normally do not vanish. In the meanwhile, hair loss in women takes roughly 10 y to appear. Women's baldness is more varied than men's. The volume of women's hair decreases with age, and some individuals are born with fine, scant hair. Because children and adolescents have less hair, this is natural and does not need special care. Variables like illness, hormonal changes, medication usage, environmental factors, and genetics can contribute to full hair loss [19, 20].

Patterned baldness

Baldness at the position of the head is referred to as Patterned Baldness (PB) [21]. The main cause of patterned baldness is a genetic additional hormones of a male identified as androgenic alopecia. Other causes, like chronic stress, an imbalanced diet, or even shampoo that is harsh on the scalp, might trigger hair loss. For males, there are 7 different forms of PB, ranging from the lowest to the most pain. For

every kind, a lateral picture of the face and top view of the head is provided. The following are examples of these types:

Tier 1: There is no PB issue.

Tier 2: On the front area of the scalp, a PB appears.

Tier 3: The depths of the temples are increasing.

Tier 4: The PB has made it to the vertices.

Tier 5: The PB is visible, and there are balder areas than hairy areas.

Tier 6: Only the sides of the head contain hairs, while the vertex is smooth.

Tier 7: The PB is certainly in place, except for the low crowns; there is no hair on the head.

Effective factors in hair loss

Baldness is caused by a variety of causes; some of them are exclusively effective in women and others in males. A few of them are listed below [22].

• Stress and depression, Genetic factor, Iron deficiency, Surgery record, Cosmetics, Pregnancy, Nutrition, Diseases, Gender, Drugs.

The place of deep learning and machine learning in ai

ML, AI, and DL are 3 concepts that are now usually utilized interchangeably to denote the smart intellectual systems or tools. In fig. 2, we show where deep learning stands in the evaluation to ML

and AI. [23]. Deep learning, as depicted in fig. 2, is a subsection of machine learning and a subsection of artificial intelligence as a whole. Overall, artificial intelligence as is a means for incorporating humanoid performance and intellect into computers or software [24], while machine learning is a technique for knowledge from information or practice [25], that programs the creation of analytical models. Data-driven learning approaches that involve multi-layer neural networks and analysis are referred to as deep learning. The word "deep" in the deep learning algorithm refers to the idea of multiple layers or stages of data processing to construct a data-driven model.

As a result, deep learning may be regarded one of artificial intelligence as key technologies, a limit for artificial intelligence as that may be utilized to create intellectual systems and mechanize processes. More crucially, it elevates artificial intelligence to a different level, dubbed "Cleverer artificial intelligence." Because DL can learn from data, there is a close link between DL and "Data Science" [26].

DL methods might show a major role for advanced analytics and intelligent choice-making in information science, which is often defined as the whole method of discovering meanings or perceptions in statistics in a specific issue area. As little more than a result, we can reach the conclusion that machine learning innovations have the ability to modernize the present state, significantly in relation of an advanced computing machine, as well as capable of contributing to innovation automated processes, pleasurable, and advanced algorithms, all of which align with Industry 4.0 goals.
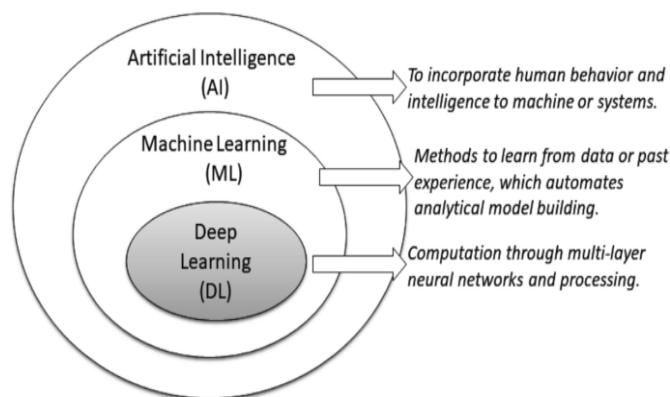

Fig. 2: Place of deep learning, comparing with machine learning and ai

Machine learning algorithms

Machine learning is a branch of science that studies the concept, efficiency, and characteristics of learning algorithms and systems. It is an extremely multidisciplinary area that incorporates principles from a variety of domains, including AI, optimization theory, information theory, optimal control, statistics, cognitive science, and a variety of other scientific, engineering, and mathematics disciplines [27-29]. In general, ML is classified into three types: supervised learning, unsupervised learning, and reinforcement learning [30].

Deep learning techniques

DL is the most powerful, guided, time and cost-effective ML approach. Deep learning is not a specific learning approach; instead, it comprises a diverse set of procedures and topographies which might be implemented to a diverse set of complicated circumstances. To uncover the description and differentiating properties, the technique employs a tiered approach. DL algorithms have made significant progress in terms of efficiency in a broad variety of apps, including security technology. The deep learning paradigm uses huge ground truth-provided data to uncover unique features, and combinations of features, and then produces an integrative feature extraction and categorization model to fig. out a

variety of applications. In this section, we'll look at some of the best techniques and frameworks.

• Restricted Boltzmann Machine (RBM)

• Convolutional Neural Network (CNN)

• Long Short-Term Memory (LSTM)

• Recurrent Neural Network (RNN)

• Gated Recurrent Unit (GRU)

• Deep Stacking Networks (DSNs)

• Auto-encoders (AEs)

• Deep Belief Network (DBN)

Feature extraction techniques

The feature selection problem has the goal of finding the smallest subset of all features that are the most relevant for a machine learning task. A feature selection method combines a search strategy for signifying novel feature subsets with an assessment measure for scoring the different feature subsets. The utmost basic approach is to evaluate every potential subset of characteristics to discover the

one that has the lowest error rate. Feature extraction methods are employed to get characteristics that will help in picture organizing and identification. This algorithm may be beneficial in a variety of image processing applications, such as character recognition. Numerous methods are used to extract features like-

- Color

- Texture

- Shape

Alopecia areata (AA) detection

T cells induce AA, which is a highly heritable inflammatory illness of the hair follicle. Female androgenetic alopecia (AA) is the most common cause of female baldness in adult women, and it has a significant impact on the quality of life of those who suffer from it. To put it another way, non-scarring alopecia is caused by the progressive shrinking of follicles, which results in a loss of hair density. Despite the disorder's high prevalence and psychological implications, its pathophysiology, which is influenced by genetic, hormonal, and environmental variables, remains a mystery. In addition, each patient's response to treatment is different. The important clinical, epidemiological, and pathophysiological characteristics of female pattern hair loss were examined in this article [31].

The Degree of Alopecia Tool rating system was re-created using a computer imaging method reported in this paper [32]. An image collection of four view-standardized photos of paediatric alopecia areata was developed, and texture evaluation was utilized to discriminate between normal hair and bare scalp. To test an automated method for the SALT score, the Children's Hospital of Philadelphia Dermatology Hair Clinic gathered 250 pictures from more than 100 children ages 2 to 21 over one year [33].

A two-pronged approach to treating female pattern hair loss is possible. Stabilize or reverse the shrinkage of hair follicles. Antiandrogen treatments (cyproterone acetate but rather a spironolactone) and topical minoxidil may be used to treat moderate to severe FPHL (Female Pattern Hair Loss). Maximum people with mild-to-moderate FPHL can halt the disease's development and reverse its shrinkage if medicinal therapies are administered appropriately. For certain people with severe FPHL, options like hair systems or surgery can be an option.

Hair loss feature (HLF) extraction from the skull picture is used in this work [10] to avoid baldness and scalp self-diagnosis. Microscopy may be put on a smart device to retrieve HLF. Gridline selection and Eigenvalues are used to derive the HLF from the skull picture. Microscopy input and light reflection were both reduced by image processing before photographing the skull. HLF is then retrieved from the pre-processed scalp picture using a different algorithm for each algorithm to assess the progress of hair loss. HLF is defined as an individual's total hair follicle count also length and thickness of their hair.

There are various forms of hair loss, the most prevalent of which is AA. Baldness diagnosis and prognosis may be improved with the use of computer-aided identification, according to [34] In this study, researchers attempted to construct a DL framework for SALT (Severity of Alopecia Tool). The scalp and hair loss areas had Jaccard similarity values of 0.941 and 0.963, resp.

Hair loss disease using various learning techniques

Neuronal network recognition of alopecia in human people was evaluated and its accuracy was determined by [35] Backpropagation is used to categorize individuals with alopecia and those without alopecia in the proposed approach. The suggested system's efficiency and regress plots are used to evaluate it. The suggested approach has an accuracy rate of 91 percent, which is sufficient for a clinical expert to make his or her judgments.

A paradigm for classifying healthy hair and AA has been suggested A total of two hundred photos of healthy hairs and 68 photographs of AA from the Figaro1k and Dermnet datasets were utilized to perform image preprocessing. Next, texture, form, and color features were extracted. SVM and KNN classification algorithms are then used to train an ML model using 70% of the photos. In the end, just a

portion of the original picture collection was utilized for testing. According to a 10-fold cross-validation, SVM and KNN had 91.4 and 88.9 percent accuracy, respectively [9].

Deep learning algorithms for identifying hair loss levels in males using facial pictures in this research. In this situation, a special training database, including face photos with varying degrees of baldness, has been generated. Furthermore, despite the limited accessibility of hairs in such images, a matching approach for mechanically categorizing face images to design categorization tables of male baldness from the medical field is provided. The outcomes of the experiments demonstrate the potential and efficiency for medical, security, and business apps [21].

ScalpEye, a DL-based intelligent skull examination and diagnostic system, as an efficient inspection and diagnostic method for scalp hair physiotherapy as part of skull health care in this article. ScalpEye system comprises transportable skull hair imagery microscopy, a mobile device app, cloud-based AI training servers, and a cloud-based administrative framework. 4 typical scalp hair problems may be detected and diagnosed with the ScalpEye technology (dandruff, cellulitis, baldness, and greasy hair). In this work, they examined various prominent item identification fig. and choose Faster R-CNN by Inception ResNet v2 Atrous model for picture recognition in the ScalpEye system to evaluate and diagnose scalp hair issues. According to the trial findings, the ScalpEye system may identify 4 typical skull hair problems by an average precision range from 97.41% to 99.09% [36].

They employed proposed models (Inception-3V3, VGG-16, VGG-19 and Squeeze-Net) to extract features in this work [37] 70 % of the database is utilized for training, while they remain 30 % is utilized for testing, resulting in a 7:3 split. As a result, employ the techniques like ANN, SVM and logistic regression to reach a maximum of 98.3% accuracy.

CONCLUSION

It affects millions of individuals throughout the globe, particularly those who have a family history of the disease. Initially, the immune system attacks the hair cavities, disrupting their usual operative and limiting future hair development. The result is hair thinning. Tracheoscopies and biopsies are often required to confirm alopecia areata as the source of hair loss. Diagnostic procedures have many drawbacks, including the question of how many tests are necessary for an accurate diagnosis. Consequently, there is a lot of room for fresh study into alopecia areata categorization and diagnosis. For diagnostic reasons, ML methods and their modified variants have been implemented in a diversity of medical area. Different machine learning techniques have been used in dermatology to provide accurate diagnoses and predictions. Estimation models are built using healthy hair photos in all these machine learning approaches.

AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

Declared none

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