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An Analysis on the Bone Age Assessment Methods for Efficient Content Based Image Retrieval

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Abstract — This survey provides the automated Bone Age Assessment (BAA), discusses the requirement for BAA, Automated Approaches and its comparison.BAA is an innovation which empowers us to determine the age. BAA of strange people is one of the mainly significant issues in a medical procedure for evaluation of biological maturity of children. BAA is performed usually by comparing the left-hand wrist radiography with an atlas of known sample bones. This evaluation and methods will work resolve in the future to enlarge the study in the system to bone age assessment and employ more techniques, tools and deeper examination to achieve this thought.

Keywords—BAA, Automated Methods, Standard Methods

I. INTRODUCTION

The Content-Based Image Retrieval (CBIR) approach has become popular in medical imaging as well as crime prevention in modern years. The CBIR system was developed in the 1990s to resolve troubles meet in text-based image retrieval. The CBIR method is supported for querying by an image. BAA often spoken as skeletal age assessment, is an experimental method for evaluating the stage of skeletal maturation of a child. BAA is a radiological assessment to discover out the dissimilarity between the skeletal bone age and the chronological age. CBIR is a robust method to determine age independent of bone measurements.BAA is not introducing a new field of skill in medical science, in the nineteenth century, the age was predictable by dentists and tooth eruption was considered as a reliable method to identify the age of a child. Rontgen exposed X-rays in 1895 and his innovation made a revolution in the evaluation of age of living subjects. This improvement based on radiography of the skeleton was used as a match to tooth eruption [1]. The researchers tried to define the age of the subject based on the radiological defined maturation of the hand wrist bone. Somewhere around 1950 and 1980, the most important methods for the estimation of age based on radiological analysis of the carpus bone were characterized as Greulich and Pyle (GP) and Tanner-Whitehouse (TW).

II. CONTENT-BASED IMAGE RETRIEVAL (CBIR)

Content-Based Image Retrieval (CBIR), also known as Query By Image Content (QBIC) and Content-Based Visual Information Retrieval (CBVIR) is the application of computer vision techniques to the image retrieval problem, that is, the trouble of penetrating for digital images in huge databases. CIBR is an application of computer vision where digitally similar images are retrieved from the largest database on the basis of their content. Content in this background refers to the information that explains the image like color, texture, and shapes. CBIR provides support to the radiologist for BAA. BAA using CBIR provides a healthy resolution without an outline and measuring bones.

A. Content-Based Medical Image Retrieval

In present years, the medical Imaging field has been increasing and is getting a large deal more attention in methods and tools, to control the investigation of medical images. To support Medical Decision making, many imaging modalities, such as Magnetic Resonance Imaging (MRI), X –beam Computed Tomography (CT), ultrasound is currently available. A Medical and General purpose Image Retrieval (MGIR) method is utilized for recovering medical and general purpose images from databases, robust for scaling and transformation of objects within an image. For organizational, medical, training, and research activities, medical image database systems are promising as a significant element of Picture Archiving and Communication Systems (PACS).

III. BONE AGE ASSESSMENT

Bone age is the measure of maturity of the human bones. As a person grows from fetal life through the early days, teenage years, and finishes growth as a young adult, the bones of the skeleton change in size and shape. These changes can be seen by x-ray. The "bone age" of a kid is the standard age at which children reach this period of bone maturation. A child's present height and bone age are able to be used to calculate adult

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height [2]. The Majority usually used method is based on a single x-ray of the left hand, fingers, and wrist. A hand is with no trouble x-rayed with minimum radiation and shows many bones in a sole view. The bones in the radiography are contrasted to the bones of a standard atlas, usually "Greulich and Pyle". A more complex method also based on hand x-rays is the "TW2" (TW = Tanner Whitehouse) method. The major improvement is the removal of the variability of evaluation among different human raters. The Bone age rating is a procedure well-suited for automation by a computer.

A. Need For Bone Age Assessment

- Visual similarity based medical image retrieval helps in retrieving similar case histories and help in diagnosis.
- Assists both the Physician and the Technician
- Automated method based on CBMIR assesses skeletal Maturity.
- CBMIR with BAA finds its use in assessing the bone age that plays a vital role in child development, Height Prediction, Growth disorders etc.
- Early Marriage is identified in children's who are not having birth proof.
- Children's are at risk of immature recruitment into Military forces.
- Kids with no ID or birth record not just have less chance of patience in sentencing and the compensation of the facilities in juvenile treatment centers, but are likewise treated as adults for giving punishments in law enforcement.
- Unregistered or refugee children are susceptible to many forms of prejudice and hurt.

B. Difficulties in Manual Approaches

- Dimensions might differ from investigator to investigate, and hence the since observation may differ.
- The manual measurements might prompt to inaccuracy.
- Time-consuming processes.
- These methods can be functional only on alive human bone.
- The process can fail due to overestimation or underestimation of bone measurement lengthwise or bone viewpoint and consequently contribute to disability or irregularity.

IV. RELATED WORK

- Michael and Nelson (1989) urbanized HANDX: "A Model-based system for automatic segmentation of bones from digital hand radiographs" [3].
- Pietka et al. (1991) developed a BAA method based on independent analysis of the phalangeal regions based on PROI- Based System [4].
- Tanner and Gibbons (1994) developed the Computer-Assisted Skeletal Age Scores (CASAS) [5].
- Cheng et al. (1994) anticipated a method to extract a region of interest (ROI) for texture analysis, with particular attention to patients with hyperparathyroidism. The techniques included multi-resolution sensing, automatic adaptive thresholding, detection of orientation angle, and projection is taken perpendicular to the line of the least second moment [6].
- Drayer and Cox (1994) designed a computer-aided system to estimate bone age based on Fourier analysis of radiographs to produce TW2 standards for radius, ulna and short finger bones [7].
- Al-Taani et al. (1996) classified the bones of the hand-wrist images into pediatric stages of maturity using Point Distribution Models (PDM) [8].
- Wastl and Dickhaus (1996) proposed a pattern recognition based BAA approach which consisted of four major steps: digitization of the hand radiograph, segmentation of ROI, prototype matching and BAA [9].
- Mahmoodi et al. (1997) used Knowledge-based Active Shape Models (ASM) in an automated vision system to assess the bone age[10].
- Bull et al. (1999) made a remarkable comparison of GP and TW2 methods. An age though, this comes near was significantly sooner than the original, it may be less accurate. The TW2 method relied on the methodical assessment of the adulthood of all the bones in the hand and wrist. The calculated intra-observer difference was better for the GP method than in the TW2 method. They finally suggested TW2 technique to be rather used as the only BAA method when performing serial measurements of a patient [11].
- Pietka et al. (2001) conducted a computer-assisted BAA procedure by extracting and using the epiphyseal/metaphyseal ROI (EMROI). From each phalanx 3 EMROIs took out which include: metaphysis, epiphysis, and diaphysis of the distal and middle phalanges, and for the proximal phalanges, it included metaphysis, epiphysis, and upper part of the metacarpals of proximal phalanges. The diameters of metaphysis, epiphysis, and diaphysis of each EMROI were measured.

The extracted features described the stage of skeletal development more objectively than image evaluation [12].

- Niemeijer et al. (2003) automated the TW method to review the skeletal age from a hand radiograph. They employed ASM previously defined by Cootes et al. (1993) to segment the outline of the bones [13].

- Mart´ın-Fern´andez et al. (2003) described a technique for record human hand radiographs for automatic BAA by means of the GP method. They use a segmentation- by-registration procedure to carry out a detailed shape analysis of the bones of the hand [14].

- Aja- Fernández et al. (2004) anticipated a fuzzy logic based neural architecture for BAA.[15]

- Luis-Garc´ıa et al. (2003) presented a fully automatic algorithm to detect bone contours from hand radiographs using active contours [16].

- Lin et al. (2004) proposed a novel and effective carpal bone image segmentation method using Gradient Vector Flow (GVF) model, to take out a selection of carpal bone features [17].

- Zhang et al. (2007) developed a knowledge-based carpal ROI analysis method for fully automatic carpal bone segmentation and feature analysis in bone age assessment by fuzzy classification [18].

- Giordano et al. (2007) designed a computerized method for BAA using Difference of Gaussian (DoG) filtering. The bones in the EMROIs took out by means of the DoG filter and enhanced using an adaptive thresholding obtained by histogram processing. Finally, the main features of these bones were extracted for theTW2 assessment [19].

- Hsieh et al. (2007) anticipated an automatic bone age assessment method found in the phalanx geometric characteristics and carpal fuzzy information. From the phalanx ROI and carpal ROI, features were extracted and used in estimating phalanx bone age and carpal bone age respectively [20].

- Liu et al (2007) proposed an automatic BAA method with template matching based on Particle Swarm Optimization (PSO) [21].

- Trist´an-Vega and Arribas (2008) designed an end-to-end system to moderately automate the TW3 bone age assessment process, by means of a customized K-means adaptive clustering algorithm for segmentation, extracting up to 89 features and employing LDA for feature selection and in conclusion approximation bone age using a Generalized Softmax Perceptron (GSP) Neural Networks (NN), whose optimal complexity was estimated via the Posterior Probability Model Selection (PPMS) algorithm [22].

- Thodberg et al. (2009) proposed a 100% automated approach called the Bone Xpert method. The architecture of Bone Xpert divided the processing into three layers: Layer A to rebuild the bone borders, Layer B to calculate an inherent bone age value for each bone and Layer C to change the inherent bone age value using a comparatively simple post-processing [23].

- Mart´ın- Fern´andez et al. (2009) proposed a landmark-based flexible registration procedure named articulated registration. The method registered individual bones a fine and soft tissue elastically so that long skeletal structure was kept up directly while a constant and soft change was getting evermore the image. They as well show so as to the planned articulated registration outperformed the substitute based on Thin-Plate Splines (TPS)[24].

- Giordano et al. (2010) presented an automatic system for BAA using the TW2 method by putting together two structures: the initial using the finger bones - EMROI - and the next using the wrist bones - CROI. Then the TW2 phase is allocated through merging Gradient Vector Flow (GVF) Snakes and DoG filtering [25].

- Thangam et al., (2012) describes a computerized BAA method for carpal bones, by extracting features from the convex hull of each carpal bone and be appropriate them to approximation the bone age [26].

- Mansourvar et al., (2012) developed a fully automated BAA system that uses compression techniques based on the histogram techniques [27].

- Nikhil Dharman.M.K, Jeban Chandir Moses et.al (2014), discussed the results acquire from each bone age estimation methods and propose the best method based on the correctness and effectiveness. The effect demonstrates so as to the ER (Eklof and Ringertz) performance is estimation the bone age with high correctness when contrast by means of GP and TW methods [28].

- Dr.P. Thangam and Dr.T.V. Mahendiran, (Mar 2015) offered Tetrolets –Based System for Automatic Skeletal Bone Age Assesment. In this System, Tetrolets are used in the Combination with Particle Swarm Optimization (PSO) for Segmentation [29].

- Marjan Mansourvar et al. (2015) designed An Automated System for Skeletal Maturity Assessment by Extreme Learning Machines. A new fully automated method based on content-based image retrieval and using extreme learning machines (ELM).The estimation results of ELM models are compared with those of genetic programming (GP) and artificial neural networks (ANNs) models [30].

- Simerjeet Kaur, (August 2016), A Comparative Study of Techniques for Bone Age Assessment using Image Processing. In this review paper, various methods for bone age assessment like active shape modeling random forest regression method, Greulich& Pyle method, Tanner and Whitehouse method and RUS method with their advantages and disadvantages are discussed [31].

V. DIFFERENT AUTOMATED METHODS FOR BAA

A. HANDX System

The primary partially automated system for BAA was initiated by Micheal and Nelson in 1989[32]. This structure reduces the difference between the observer and the finished result is precious in the direction of recognizing anomaly of skeletal development within children. This structure operates in three divisions: preprocessing, segmentation, and evaluation. In the major organization the radiographs are identified to support in the next measure. The segmentation systematizes the location in exacting bones in the hand, in addition, disconnects the edges of the bone, and the quantitative parameters are examined in the terminal phase. This semi-automated construction has no reasonable accuracy when the hand image is connected and has not been assessed on an unlimited level.

B. PROI-Based System

In 1991, Pietka, along with his research team developed a technique stand on PROI examination. PROI is the region that comprises the phalanges and epiphyses [33].For the inspiration of bone age, in the most important method, the structure pass through a filter a straight line and the lower bound of the PROI is found before the yielding tissue among the section circle and the first finger is sharp. In the next stage, the higher limit holds a horizontal line at the boundary of the third finger is divided away. At the stage when the upper, lower, left, and right boundaries of the PROI have been completely out, the separation organizes start. A gradient image is used for segmentation of the finger cymbals and the yield boundary depends on the exact assessment to discover the bone boundaries. The width of the judgment of pixels toward the rest of the condition is loftier than the core segment .In this method, the separation line connecting the third distal, middle, and proximal phalanges is calculated. This opinion makes use of the normal board put up by the Garn amass together through phalangeal distance end to end to change in excess of keen on skeletal age. The construction has been assessing by 50 Computer radiographs (CR) of patients and an association of the cases with an observer (radiologist).The major difference yield beginning the appraisal was 0.02mm with an inference error of 0.08mm.

C. The CASAS System

In 1994, Tanner and Gibbons proposed a computer-based skeletal age score organization (CASAS), launch on the Tanner and Whitehouse2 (TW2) method using radius, ulna, and little bones (RUS) [34].This semi-automated structure digitized radiography images with a light box and monochrome camcorder. Every bone is indomitable on the automated camera make use of superimposing plan. The computer based reviews the bone age by organizing and judgment the finest standard in light of rapid Fourier transform. The resolution reduces the root-mean-square error among the coefficients of the Fourier transforms from the unclear bone from the available bone layouts. The training is transported by averaging the Fourier transform coefficients making the most of 10 images from bone stages. The structure improves to a five-root mean square by using a Gaussian function. The images are simply linked to set up a normal skeletal growth for TW and not for construction up the real bone keep count style. In any case, in the framework the layouts have a crucial part and determination of the source for making the format is essential. The CASAS structure has been demonstrated and evaluates making use of X-ray image of children in characteristics and an even pathologic situation. There has been some exploration on an examination between the CASAS technique and the manual TW strategy and the outcomes show a sensible declaration that the CASAS estimation is more precise than the manual TW technique.

D. Phalanges Length Based System

The first version of a fully automated system was developed in the year 1990 and is based on a Picture Archiving and Communication System (PACS), which make use of the digital atlas of radiographs in a restricted mode [35]. This basic utilizes a rough size in the standpoint of the phalangeal length evaluation taken from phalange length tables set by Garn. The framework extricates extracting area of the hand, wrist in view of the disagreeable assessments. The image processing approach and computation of the construction used to review and get better the skeletal elements are extremely simple though tiresome. The framework operates a web-based image, giving out with a digital atlas book utilizing a query language. However, this method is bringing in as a rational and practical automated means of BAA using functional fuzzy classification to uncover the noisy data and objective conclusion. The fuzzy systems are dependent on the reference population group because of using the relationship with age rather than measuring the skeletal maturity, which is a significant restriction. Therefore, most of the test consequences unrestricted for the system are standing on the accuracy of the region of extraction or segmentation; a relationship between the predictable age of the system and the chronological age shows roughly a year's variation. The method tries to get better the segmentation of the phalangeal epiphyses by being relevant Gibbs random with contour model segmentation, to improve the carpal bone analysis and radial epiphysis. BAA using the phalangeal length always raises the query of what happens to the judgment if the preliminary assessment is inaccurate, which is the main drawback of this

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method, and, hence, the phalangeal length is not a consistent indicator for skeletal maturity.

E. Neural Network Based on the Radius and Ulna

Vega and Arribas proposed a computer-based system to calculate the bone age based on the TW method and using the radius and ulna [36].This framework is helped with manual historic points and then applies an adaptive clustering method for segmentation of the radius and ulna. The strategy applies neural systems in the alternative condition to formulate a posteriori probability that forecasts the fault rate; this component is particular to this technique. The scope of the mean distinction of the framework and observer is large and this strategy is constrained to only four TW3 levels. Notwithstanding, the analysts assert that their technique could be reached out by enhancing the bone segmentation. This technique proposes that a neural system is significant for supplementary assessment.

F. BoneXpert System

The BoneXpert system is an additional automated method for BAA that was introduced in 2009.This method is based on shape-driven active exterior and the TW RUS-based approach (using the radius, ulna, and short bones) [37].The shape and strength highlights make a dynamic algorithm of the lively appearance display. An arrangement of parts of more than 3,000 bone shapes are rotated and scaled, in view of the Gobar filters which the parameters are framed in the dynamic appearance show. Thirty coefficients were decided for elements of images using a linear regression method encouraged into the dynamic appearance demonstrate. In spite of the information, the simplicity of use of the framework is still under assessment; preliminary testing reveals that the execution is sensible and that the precision is expressed as 0.42 years for utilizing the Greulich and Pyle (GP) technique and 0.80 years of utilizing the TW2method. The negative response rate of the structure was approximately 1%for low down excellence though it has extended to 18% now and another time for the radius and ulna. The particular purpose of this technique is that it surveys the precision of the bone age using the relationship between the X-ray image and linear development. The BoneXpert framework has been published as a commercial package since January 2009.

G. Automated Web-Based System Using Histogram

In 2012,Mansourvar et al. developed a completely automated BAA system that uses compression techniques based on the histogram techniques[38].This approach deals with an image repository and similarity measures and uses a Content-Based Image Retrieval (CBIR) technique for image processing. The framework incorporates a learning base comprising of 1100 hands X-ray radiographs characterized by gender and ethnicity in addition. The framework is not reliable for images with poor image quality or abnormal bone structure.

APPROA C-HES & YEAR	**AUTH OR**	**METHO D**	**ADVANT A-GES**	**DISADV - ANTAG ES**
HANDX System, 1989	Micheal and Nelson	Segment-ation and Isolated	Reduced inspection inconsisten -cy	No realistic precision
PROI System, 1991	Pietka et al.	Segment-ation of Phalanges and epiphyses	Low represents dissimilarit y and mistake rate.	Estimate in Small level
The CASAS System, 1994	Tanner and Gibbons	Based on the TW2 RUS Method	More precise than manual TW Method	Not effort for assess with pathologi -cal difficulty
Phalanges length based System, 1990	Pietka et al.	Segmentat ion of phalangeal length or carpal	Decrease Subjective result	Depends on the situation populatio n group
Neural Network support on the radius and ulna, 2008	Tristan – Vega, and Arribas	Adaptive clustering performan ce for segmentati on	Improving the bone segmentati-on	Restricte d to four TW3 levels
BoneXpe-rt System, 2009	Thodber g et al.,	Based on the Shape driven and the TW RUZ Based.	High Accuracy	Rejects images in poor quality
Web-Based System Using Histogram , 2012	Mansou -rvar et.al.	Based on the Histogram Technique .	Removes the segmentati-on method	Not reliable for images with poor image quality or abnormal bone structure

Table.1: Comparison of Automated Approaches in BAA

VI. RADIOGRAPHY IMAGES

Radiography is an imaging approach that utilizations electromagnetic radiation other than visible light principally X-rays, to perceive them within the structure of a non-consistently produced an opaque object, for instance, the human body. The part of the radiographer has changed drastically as a result of more advanced equipment. Computational Forensics (CF) is a developing range in the research area. Scientific issues explored physically for correct results are tedious. This incorporates Computer based examination for taking care of the measurable issues. In this way computer forensic is likewise regarded as advanced criminological or measurable data innovation. Computerized forensics depends on X-ray image examination, CT/MRI scan image investigation and ultra sound investigation. The first two are the digitized images of bones through laser beam and the later one is continuous video frames, for example, Digital Imaging and Communications in Medicine (DICOM) examination. The Bones can be imaged through X-ray, MRI (Magnetic Resonance Image), CT (Computed Tomography) and DICOM images.

VII. STANDARD METHODS FOR BAA

A. Greulich and Pyle Method (GP)

"The Radiographic Atlas of Skeletal Development of the Hand *and Wrist"*, by Dr. William Walter Greulich and Dr. Sarah Idell Pyle is still one of the most commonly used atlas for bone age measurement by radiologists in Pakistan and in the West [40]. It encloses suggestion images of male and female procedures of the left wrist and hand from 1-18 years for females and `1-19 years in male. Additionally, clarification with regards to the slow age related changes in the bone structure is furnished with every standard image. Bone age is computed by contrasting the left wrist radiographs of the subject with the closest coordinating reference radiographs given in the atlas which is standard for the different ages. Left hand image is generally utilized for age evaluation or skeleton assessment. The hand bone advancement stage is given as an Atlas by W. W. Greulich and S. I. Pyle. These atlases are the base model for examining age related changes in the human bone design structure. This technique is popularly referred as GP strategy by the majority of the creators. This strategy is less difficult and quicker than other radiograph based methods. GP Atlas standards are viewed as relevant and reliable for children in Australia and the Middle East. The difference between the computed bone age and chronological age is noted when this strategy is used for assessing bone age of Asian children.

B. Tanner Whitehouse (TW2) Method

One more atlas has been offered by Tanner and Whitehouse (TW: TW1, TW2, TW3) in the year 1962.The learning was alert next to the age inference but relies on the bone regular maturity. The Tanner &Whitehouse (TW) strategy interestingly is not based on the age, rather it depends on the level of development for 20 Region of Interest (ROI) in particular bones of the wrist and submit every age population. The growth level of every ROI is classified into precise stages labeled as (A, B, C, D, I) [41]. A mathematical score is known to every stage of growth for each bone independently. By summing up every one of these scores from the ROIs, an aggregate development score is computed. This score is associated by means of the bone age independently for males and females. TW method is reasonably more difficult and requires additional time; it is more precise and reproducible when contrasted with GP method.

C. FELS Method

Behind an extended break, another method FELS (Fels Longitudinal Study) was planned by A.F. Roche et al. in the year 1989 [42]. This is an automated structure which employs the scores/grade for each bone as an input for assessing the age. Unlike the GP and TW which have strategies, here it is the appraisal distribution assessed for within a comparable age group. More than 130 focuses are decided for every single bone for examination. This strategy additionally predicts the mistake correction for evaluation. It is 0.3 to 0.6 years for a child aged 1 month to 2 years and 0.2 to 0.3 years for girls from 1 to 14 years old. And age greater than 2 it was 0.3 for boys. The errors are more for infants because of bones combination stages. The FELS strategy is complicated with gigantic arrangement of focuses. It is not accessible as a software/Package for investigation/checking however, one can chip work at for actualizing this code.

METHOD & YEAR	BONE USED	ATLA-STYPE	ADVANTAGES	DISADVANT-AGES
Greulich and Pyle method (GP), 1959	Every part of the finger joint bones and carpal bones .	Hand Atlas	1. Easy and Dependable method to make use of; just by evaluating the x-ray with the atlas. 2. Once establish the age group the viewers have to make sure for older and younger stages for exact age.	1. Time-consuming Process 2. Approxima-tely 22 joints have to be processed. 3. The image must be very apparent for calculating approximat-ely the age. 4. May lead to miss categorizati on 5. The observer must be the

				specialist.
Tanner and White-house method (TW), 1962	Bones joints togeth-er with carpal, thum-p, middl-e and last finger.	Hand Atlas	1. It is supported by calculating the maturity of the skeleton bones. 2. A mathematical score is associated for each bone that is examined. 3. The age can be predicted using RUS or Carpal bones or Phalangeal bones (20) separately. 4. Accurate than GP method	1. Time-consuming process. 2. Difficult procedure. 3. At this time also the image has to be apparent enough for classificatio n. 4. The observer must be an expert.
FELS method, 1989	All the bone joints	Digita -l Atlas	1. A novel approach to age assessment using the maturity scores for every part of joints bones. 2. Easy to understand and can be employed as a program.	1. Moreover, many points (above 130) are chosen for each bone. 2. Not available as software/pa ckage: so the researchers can't test and verify.

Table 2: Comparison of Standard Methods in BAA

VIII. LIMITATIONS OF HAND X-RAY ANALYSIS

- The major restriction of hand radiography inspection is the age group. This is able to exist make use of to review presently the age up to 18 or 19 years.
- The answer is different from male and female.
- The atlases urbanized will differ through regions. Therefore, dissimilar atlases have to be bringing onward intended for a variety of states and regions.
- Age can't be predictable if the images have the failure of information such as fewer no. of fingers, joint fingers, fractured bones etc.

IX. CONCLUSION

Recently, BAA has gained substantial intellectual attention. BAA is regularly used for measuring bone development, managing of member length discrepancies, scoliosis, and the judgment of endocrine disorders and familial disorders in children and juveniles. The manual methods used to decide age are frequently time-consuming and imprecise. Hence, there is an increasing need for automated methods for determining the age of an individual with more accurate outcomes. This report is a study report on current approaches used for bone age assessment using the image processing techniques. It is expected that an automated system would improve the accuracy and precision of BAA in both clinical and research exercises. As the future work, the bone age will be assessed with Tanner White House Method because it helps in assessing the bone age accurately when compared to other standard methods.

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