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Diagnosis of Human Spine Deformity Using Simple Image Processing

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Abstract- *There is many adolescents in schools in our society and other societies who suffer from deformities in the spine, neck, and shoulders. These deformities may be very simple and only simple exercises are needed, or these deformities may be so severe that any exercises to improve these deformities are useless. To a surgical intervention to correct these deformities and treat them in the best way. That is why we presented our project, which analyzes the degree and type of distortion as soon as there is a front camera or webcam placed on the person and performs several mathematical and programmatic operations and shows an impressive result to determine the severity of the distortion and its exercises. Of course, if the deformity is very severe, the program does not provide special exercises for it, but the person needs surgery. The project aims to analysis of the degree of deformity in the spine of the body, neck, and shoulders and determine the exercises for this deformity.*

Keywords- *Thinning, Euclidian Distance, Image Processing*

I. INTRODUCTION

Scoliosis can be defined as one of the medical conditions where the spine of an individual has sideways curve. Usually, this curve is of a “C”-or “S”-shape over 3 dimensions. In some of the cases, the curve’s degree was stable, whereas in other others, it will be increased with time. In addition, the mild scoliosis does not result in issues, yet more severe conditions might be affecting movement and breathing. Usually, pain exists in adults and might be worsened with age. There is unknown cause for the majority of conditions, yet it was indicated to include a set of the environmental and genetic aspects. The risk factors involve other affected members of the family. Also, it might happen because of another condition like cerebral palsy, Marfan syndrome, muscle spasms, and tumours like neurofibromatosis. X-rays are used to confirm the diagnosis. Typically, scoliosis was categorized as functional where the underlying spine was normal, or structural where the curve was fixed. In addition, treatments are based on curve degree, cause and location. The slightest curves might be periodically observed. Treatment involves specific exercises, bracing, surgeries and posture checking. Also, the brace should be fitted to the individual and daily utilized till the stopping of the growth. Certain exercises might be utilized for decreasing the worsening’s risks. They might be achieved alone or accompanied with other treatments like bracing. Evidences that the dietary supplements, chiropractic manipulation, or exercises preventing the conditions from worsening were weak. Yet, exercises are suggested because of their benefits to health.

Scoliosis happens in approximately 3% of individuals. It is developing majorly in ages in ranges of (10-20) years. Typically, females were severely impacted compared males. The term has been taken from the Ancient Greek: σκολίωσις which is translated as romanized: skoliosis which indicates the “bending”.

Figure 1 Scoliosis Condition

Individuals experiencing scoliosis undergoing physical examinations for determining the deformity have underlying causes and for excluding the possibilities regarding the underlying conditions more dangerous compared to simple scoliosis. The gait of the individual is evaluated, with examining other abnormalities (spina bifida as indicated via dimple, lipoma, hairy patch, or hemangioma). Comprehensive neurological examinations were achieved, the skin for spots of cafe au lait, cavovarus deformity feet, indicative of neurofibromatosis, abdominal reflexes and muscle tone for spasticity. In the case where the individuals are cooperating, they will be requested to bend forward as much as they can. Which has been referred to as Adams forward bending test and frequently done on the students in schools. In the case when noting prominence, then scoliosis was a possibility, whereas X-rays might be achieved for confirming diagnosis.

As one of the alternatives, a scoliometer might be utilized for diagnosing the condition. When there is a suspect of scoliosis, the weight bearing, full spine AP/coronal (i.e. front back view) as well as lateral/sagittal (side-view) X-ray processes were typically considered for assessing the curves of the scoliosis, also lordosis and kyphosis, since they might be impacted in people experiencing the condition of scoliosis. In addition, the full length standing spine X-ray were standard approaches to evaluate scoliosis progression and severity, and if it's idiopathic or congenital in nature. With regard to growing persons, the serial radiograph procedures were acquired between intervals between 3 months and 12-month for following the progression of the curve, and, in a few examples, the MRI investigation was warranted for looking at the spinal cord.

The major approach used to quantitatively assess the curvature was evaluating Cobb's angle, which represents an angle between 2 lines that have been drawn (perpendicularly) to upper end-plate related to the involved uppermost vertebra and the lower endplate regarding the involve lowest vertebrae. With regard to individuals with 2 curves, Cobb angles were followed for the two curves. In a few individuals, the lateral bending X-rays were acquired for assessing the flexibility regarding the curves or compensatory and primary curves. Idiopathic and congenital scoliosis developed prior to 10 years old was indicated as one of the early onsets of the scoliosis. Furthermore, progressive idiopathic

early onset scoliosis might be one of the conditions that pose threat to the life and have bad impacts on the pulmonary functions. The scoliosis which can develop after the age of 10 has been indicated as the adolescent idiopathic scoliosis. The screening of the teen-agers with no scoliosis symptoms was of unknown benefits.

II. METHODOLOGY

In order to determine the deformity of the neck, back, and/or shoulders by using only webcam or camera, the frame captured must be passed by several processing stages:

1- Background subtraction
2- Binarization
3- Thinning
4- Analyzing the deformity

2.1 Background Subtraction

A background subtraction approach is used to detect moving humans in videos from static cameras. In this approach, the origin is to detect the moving objects from differences between the current frame as well as the reference frame, often referred to as the "background replica", or "background copy". As a baric, the background image should represent the scene without moving objects and should be updated regularly for adapting the different geometry settings and varying luminance. More complicated modes were extending the "background subtraction" concept beyond its literal meaning. In addition, the background subtraction approach was a major method of motion detection. It can be defined as one of the technologies using differences of background image and present image for detecting motion region, and it typically has the ability for providing data included object information. This study uses the first frame (that doesn't include any human body) for subtracting it from the next frames for the processing's duration.

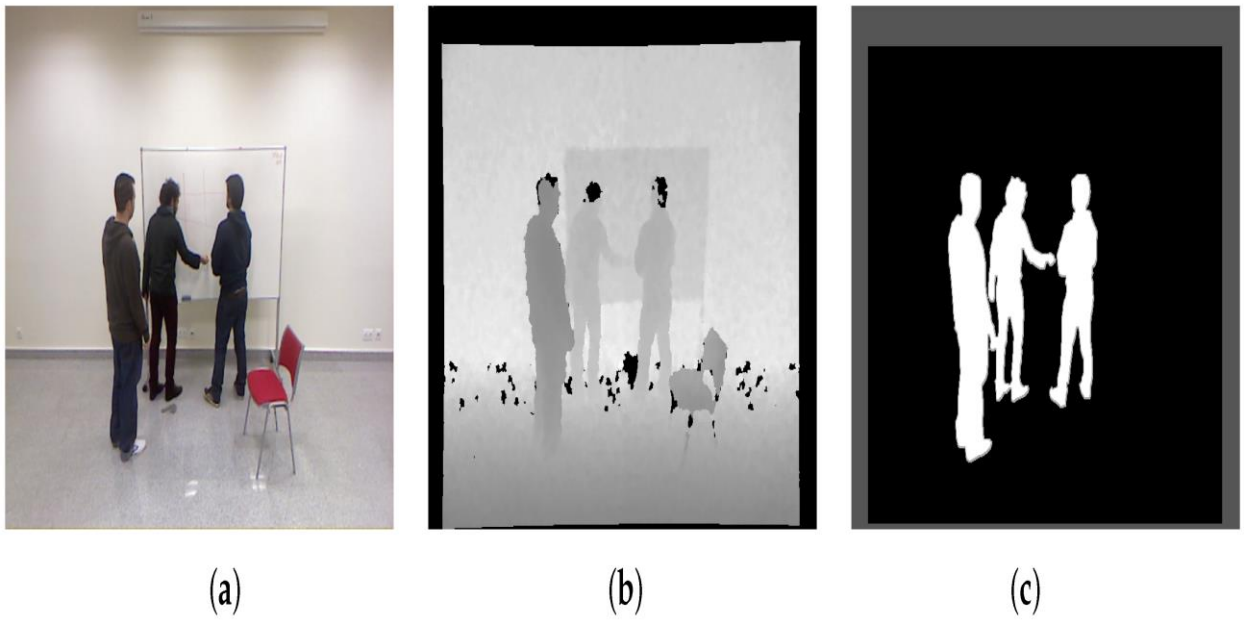

Figure 2 Example of image subtraction

The following pseudo code explains the image subtraction:

$For\ each\ frame_i \quad i = \{1, \dots, Number\ of\ frames\}$
$Input\ Forground\ objects\ at\ time\ t\ from\ Block\ A$
$object\ matching\ between\ frame_i\ and\ frame_{i-1}$
$or\ each\ component_j \ , \quad j = \{1, \dots, Number\ of\ components\}$
$if\ component_j > Valuable\ Size$
$Flag_j \leftarrow Flag_j + 1$
$Detect\ Componet\ as\ bird$
$else$
$if\ Flag_j > N$
$Flag_j \leftarrow Flag_j - 1$
$Detect\ Componet\ as\ human\ body$

2.2 Binarization

The binary image is the one which includes pixels that might have one of 2 colors, typically white and black. Also, binary images were referred to as bi level or two level, indicating that each one of the pixels was stored as single bit—,0 or 1. The names black-and-white, B&W, monochromatic or monochrome were frequently utilized for such concept, yet might be designating any images which have just one sample for each pixel, like grayscale images. With regard to Photoshop parlance, binary images are the ones the same as image in "Bitmap" mode.

Figure 3 Example of image binarization

To continue to the next step, the image must be transformed into binary (0, 1), as following:

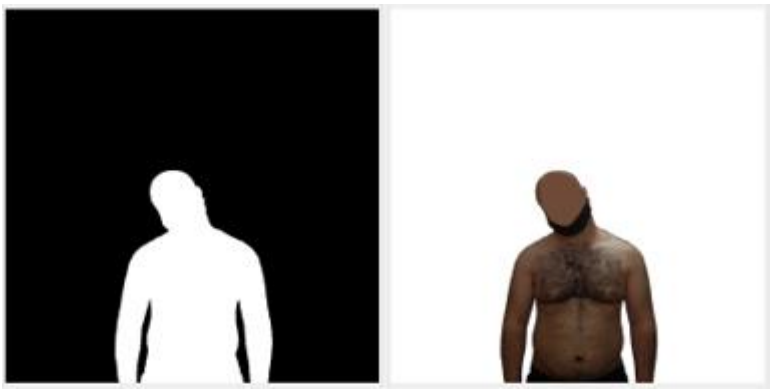

Figure 4 converting human body image to binary

2.3 Thinning

With regard to the analysis of the shape, the skeleton (or the topological skeleton) related to a shape was considered as a thin version regarding that shape which is halfway between its boundaries. Usually, the skeleton is emphasizing the topological and geometrical characteristics of the shape, like topology, connectivity, direction, length and width. Accompanied with distance regarding the points to the shape boundary, the skeleton might be serving like a shape's representation (they include all information that might be required for reconstructing the shapes). Also, skeletons have various mathematical definition types in the technical literature, and there were various approaches that were presented to compute them. A variety of the skeleton types might be identified, involving morphological skeletons, straight skeletons and so on.
In terms of technical literature, the skeleton concepts as well as medial axis were interchangeably utilized by a few researches, whereas a few other studies indicated them as related, yet not the same. Comparably, the concepts of thinning and skeletonization were specified as matching via some, and not via others. The skeletons were utilized in image analysis, computer vision, digital image processing and pattern recognition for purposes like fingerprint recognition, OCR, visual inspection or compression. Within life science skeletons have found extensive uses for the characterization of the plant morphology and protein folding on a variety of the biological scale types.

Figure 5 example of thinning

2.4 Analyzing the Deformity

We can calculate the degree of the deformity by calculating the distance between the top edge of the .thinning extracted from human body to the center vertical line horizontally

The following pseudo code explain this fact:

```
 IsFirstPixel = false;
 FirstBlackPixel = 0;
 NickPixel = 0;
 NickCount = 0;
IsSide = true;
 for x = 20 to Height
 for y = 20 to Width
}
 if (y == BaseAxisIndex(
}
 BodyAxisImage.Data[x, y, 0] = 0;
 BodyAxisImage.Data[x, y, 1] = 0;
 BodyAxisImage.Data[x, y, 2] = 0;
```



```
 continue;
{
 if (x == ((Thinning.Rows / 3) * 2((
}
 BodyAxisImage.Data[x, y, 0] = 0;
 BodyAxisImage.Data[x, y, 1] = 0;
 BodyAxisImage.Data[x, y, 2] = 0;
 continue;
{
 value = Thinning.Data.GetValue(new int[] { x, y, 0;({
 if (value == 0(
}
 if (!IsFirstPixel(
}
 FirstBlackPixel = y;
 IsFirstPixel = true;
{
{
{
Deformity1 = |BaseAxisIndex – FirstBlackPixel;|
if (DeformityNick <= 30 && DeformityNick >= 5(
print // ;"تحدب عمود فقري" Convex spine
if (DeformityNick > 30(
print // ;"استدارة الكتفين" Shoulders rotated
if (Deformity1 > 0 && Deformity1 <= 10(
}
 print// ;"لا يوجد تشوه" There is no abnormal shape of the spine
 Degree of Deformity = (Deformity1 / 2;(
{
if (Deformity1 > 10 && Deformity1 <= 15(
}
 DeformityType1// ;"بسيط" = Simple Deformity
 if (Deformity1 == 11 || Deformity1 == 12(
 Degree of Deformity = 6 ;
 else if (Deformity1 == 13 || Deformity1 == 14(
 Degree of Deformity= Deformity1;
 else
 Degree of Deformity = 22;
 {
if (Deformity1 > 15 && Deformity1 <= 40(
}
 DeformityType1// ;"متوسط" = Medium Deformity
Degree of Deformity = (Deformity1 / 2;(
 if (Deformity1 >= 30(
Degree of Deformity = Deformity1;
 if (Deformity1 > 35(
 Degree of Deformity = 35;
 {

 if (Deformity1 > 40(
```

```
}
 DeformityType1// ;"شديد" = Serious Deformity and it needs a surgery
{
```

The algorithm above could be used for both side and front of the human body to diagnose the deformity of the spine.

III. Results

The project was able to recognize the degree of deformity by passing one the conditions as following image:

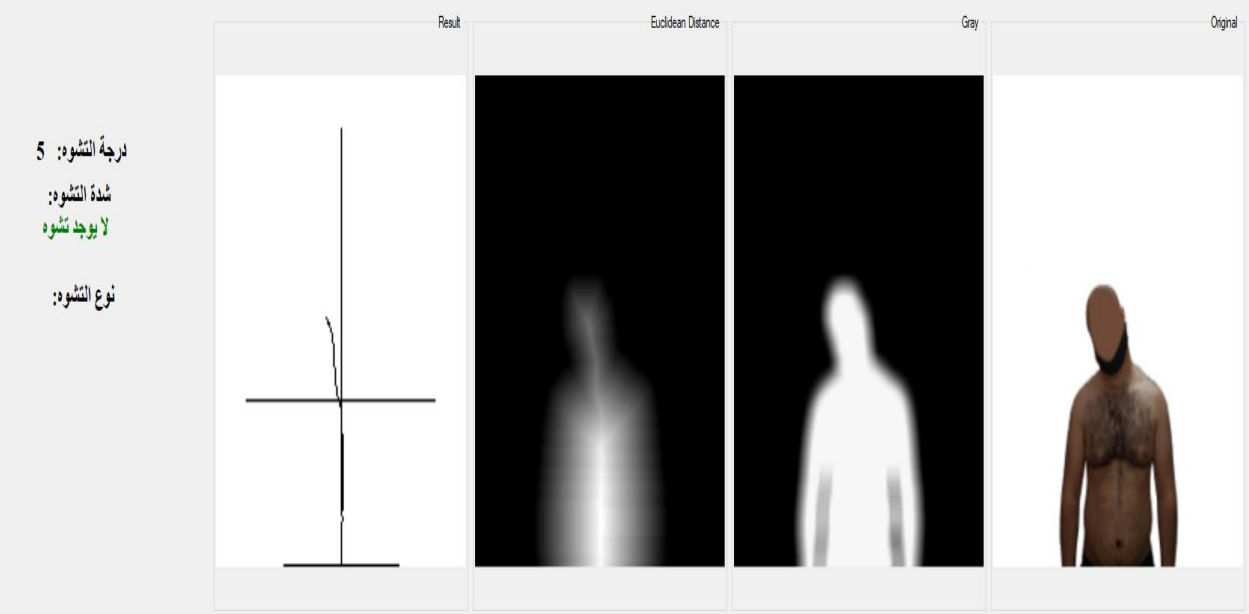

Figure 6 5 degrees deformity which has no serious deformity of this condition

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