

Analysis on Image Processing of Human Hip Joints during Lifting Using MAT Lab and ANSYS

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Abstract— Human Joint pains exhibit abnormal motion and vice versa during movements. Most of the patients were suffering from joint pains. This joint pains like Hip joints, Knee joints, Foot joints, Shoulder joints Elbow joints, and Wrist joints. Patients suffering from joint disorders visit a therapist. The therapist must correlate all these information sources regarding joint Problems. Most probable one third of all jobs in industry involve Manual Material Handling (MMH). This Manual Material Handling of human poses risk to many and cause back pain, joint pains and other problems like Knee joints, wrist joints, Shoulder joints, etc. A finite element model is used to study about the stress of human joints. Image processing techniques using soft computing like MAT Lab and ANSYS are used. A Biomedical model has been used for optimizing the lifting posture for minimum efforts. This model is also used to predict the lifting material in every individual human being. This study can be extended for loading of muscles.

Key words

Magnetic Resonance Imaging, Human Joints, Finite Element Modeling, ANSYS, Image Processing.

1. INTRODUCTION

Manual Object handling by humans in industry is one of the important & complex problems like joint pains in the human body. The joints should support the whole weight of the human body. More stress is applied during lifting the object manually. Manual object handling cause cumulative disorders to muscular skeletal system through continuous lifting / handling activities. This work related back pain, human joints, & injures are the most common muscular skeletal disorders. The human body problems like Hip joints, Knee joints Shoulder joints, Elbow joints, & Wrist joints affect because of Manual Object handling. A biomechanical model has been used for this problem.

2. LITERATURE SURVEY

[1] **Matheel E. Abdulmunim¹, Suhad M. 2012**, Image segmentation is an essential step in image analysis. Segmentation separates an image into its component parts or objects. The level to which the separation is carried depends on the problem being solved. Segmentation algorithms for images generally based on the discontinuity and similarity of image intensity values. [2]. Classical methods of edge detection engage convolving the image through an operator, which is constructed to be perceptive to large gradients in the image although returning values of zero in uniform regions.

[2] **Sangram Bana¹ and Dr. Davinder Kaur, 2011**, Fingerprint recognition or fingerprint authentication refers to the automated method of verifying a match between two human fingerprints. Fingerprints are one of many forms of biometrics used to identify an individual and verify their identity. Because of their uniqueness and consistency over time, fingerprints have been used for over a century, more recently becoming automated (i.e. a biometric) due to advancement in computing capabilities. Fingerprint identification is popular because of the inherent ease in acquisition, the numerous sources (ten fingers) available for collection, and their established use and collections by law enforcement and immigration.

[3] **Mohammad Shajib Khadem Signal, 2010** Segmentation subdivides an image into its regions of components or objects and an important tool in medical image processing [1]. As an initial step segmentation

can be used for visualization and compression. Through identifying all pixels (for two dimensional image) or voxels (for three dimensional image) belonging to an object, segmentation of that particular object is achieved [2]. In medical imaging, segmentation is vital for feature extraction, image measurements and image display [2, 3]. Graph cuts is one of the image segmentation techniques which is initiated by interactive or automated identification of one or more points representing the 'object'.

[4] K. Raja, and A. Meena, November 2012, The most commonly used radiographic techniques are known as Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET). These technologies are major component techniques in diagnosis, clinical studies, treatment planning and are widely used for medical research. The motive of automatic medical image segmentation is to describe the image content based on its features. In recent years an ample of approaches has been proposed to segment the medical images according to its merits and limitations.

3. PROBLEM IDENTIFICATION

Manual Material Handling (MMH), especially lifting, poses a risk to many and considered the prime cause of Knee joint pain and various other joint impairments. Joint pain leads to increased worker compensation and loss of productive man-hours. Approximately one third of all jobs in industry involve Manual Material Handling (MMHA). A finite element model to study and analyze the stresses on all Human Joints has been proposed to develop. Analyze Image processing techniques using soft computing like MATLAB and ANSYS. A biomechanical model has been proposed to develop for optimizing the lifting posture for minimum effort.

4. SEQUENCE OF WORK

Sequence of work can be followed by different stages like CT scan Image, Original Image properties of Input data, parameters, CAD Modeling of 2D and 3D Modeling, Stress analysis using MATLAB, Image processing, Image Segmentations, Comparison of Results, Extension of work towards Muscles.

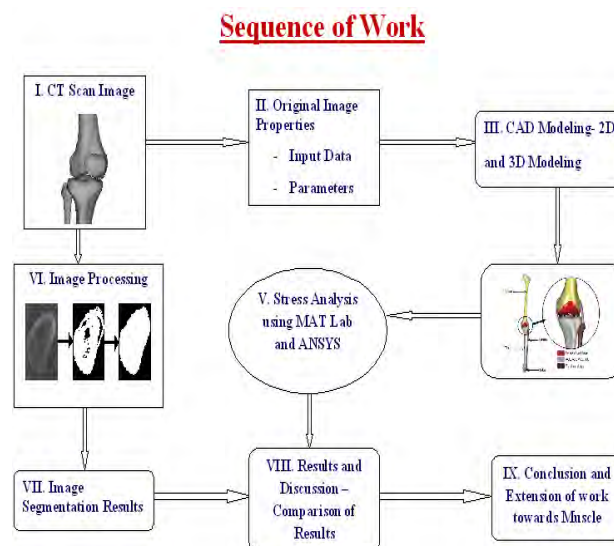


Figure 1: Block Diagram of Sequential Work

4. RESEARCH METHODOLOGY

The Original CT Scanned Image is observed from the medical Lab and taken as input data with their parameters. The input data is converted to 2D and 3D modeling by using CAD techniques. Stress analysis using MATLAB and ANSYS is applied to the output data. Image processing techniques find the exact image of both stressed and unstressed image between original CT Scanned image with 2D and 3D image. The results will be compared with original image so that the human joints problems can be analyzed in the human being. Human joints like wrist, elbow, shoulder, hip, knee, and foot joints can be analyzed with this methodology. Manual Materials Handling involves Lifting/Lowering, Pushing/Pulling, Twisting, Carrying, and Holding

5. MATHEMATICAL MODELING

CALCULATION OF BODY MASS INDEX:

Body mass index (BMI) is a measure of body fat based on height and weight that applies to adult men and women.

BMI = Weight (kg) / (Height) ²

Examples 1: Someone who is 1.60 m and weights 50 kg has a BMI of
 BMI Calculation = 50 / (1.6 x 1.6) = 19.5 <== This person is in the Normal category.

Example 2: Someone who is 1.50 m and weights 60 kg has a BMI of
 BMI Calculation = 60 / (1.5 x 1.5) = 25.8 <== This person is in the Overweight category.

BMI is proportional to your weight, so an increase in weight (muscle or fat) will increase your BMI.

BMI Categories:

BMI	Weight Status
Below 18.5	Underweight
18.5 – 24.9	Normal
25.0 – 29.9	Overweight
30.0 and Above	Obese

The result falls in the overweight or obese range, and you have other risk factors, such as smoking, heart disease, diabetes, high blood pressure or high cholesterol, get busy navigating this site to learn how to make the necessary lifestyle changes! The CDC (Center for Disease Control) reports that losing even a small amount of your total body weight, somewhere between 5-10%, can help you lower your risk of serious health problems.

LIFTING EQUATIONS AND ITS FUNCTIONS

Lifting Index (LI)

The term LI that provides a relative estimate of the level of physical stress associated with a particular manual lifting task. The estimate of the level of physical stress is defined by the relationship of the weight of the load lifted and the recommended weight limit.

The LI is defined by the following equation:

$$LI = \frac{\text{Load Weight (LW)}}{\text{Recommended Weight Limit (RWL)}}$$

RECOMMENDED WEIGHT LIMIT

The RWL is the principal product of the revised NIOSH lifting equation. The RWL is defined for a specific set of task conditions as the weight of the load that nearly all healthy workers could perform over a substantial period of time (e.g., up to 8 hours) without an increased risk of developing lifting-related LBP. By healthy workers, we mean workers who are free of adverse health conditions that would increase their risk of musculoskeletal injury. The RWL is defined by the following equation:

$$RWL = LC * HM * VM * DM * AM * FM * CM$$

Where:

- LC Load Constant
- HM Horizontal Multiplier
- VM Vertical Multiplier
- DM Distance Multiplier
- AM Asymmetric Multiplier
- FM Frequency Multiplier
- CM Coupling Multiplier

Example: A worker lifts 15 kg boxes from the table to the shelf five times an hour. Notice that there is a barrier between the worker and the box.

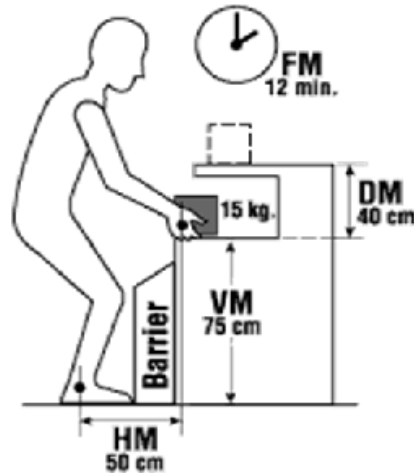


Fig 2: Human Lifting Weight about 15 kg

The recommended weight limit (RWL) for the task:

The weight of the load. Weight - 15 kg

The Recommended Weight Limit for the task.

$$23 \text{ kg} \times 0.5 \times 1 \times 0.97 \times 1 \times 1 \times 1 = 11.15 \text{ kg}$$

Compare the weight of the load against determined Recommended Weight Limit for the task.

The weight of the load is 15 kg. This value is higher than the weight limit of 11.15 kg.

Therefore, the TASK IS DANGEROUS.

6. PERFORMANCE MEASURE

The Peak Signal to Noise Ratio (PSNR) value can be calculated for the noisy image compared with the original image. The value of PSNR and MSE (Mean Square Error) is found out for this method experimentally.

$$MSE = \sum_{x=1}^X \sum_{y=1}^Y (S - T)^2 / X * Y$$

Where S is the original image and T is filtered image. X, Y is the size of the image.

$$PSNR = 10 \log_{10} (255)^2 / MSE$$

Normalized image pixel value is 255, the value obtained are in the interval [0, 1].

Image Pre-Processing (Filters)

Linear filter

Weiner filter

Mean filter

Linear filter:

Linear filter removes some of the noise from the image. Linear filter perform very less noise filtering of images. Linear filter tries to produce sharp edge but perform very poor because of the presence of signal independent noise. Linear operations calculate the resulting value in the output image pixel f(i,j) as a linear combination of brightness in a local neighborhood of the pixel h(i,j) in the input image.

Weiner filter:

Weiner filter is to reduce the amount of a noise in a signal. This is done by comparing the received signal with an estimation of a desired noiseless signal. Wiener filter is not an adaptive filter as it assumes input to be stationery. Signal and noise are both linear stochastic processes with known spectral properties. The aim of the process is to have minimum mean- square error. Before implementation of the filter it is assumed that the user knows the spectral properties of the original signal and noise.

Mean filter:

Mean filtering is a simple, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images. The idea

of mean filtering is simply to replace each pixel value in an image with the mean ('average') value of its neighbors, including itself. This has the effect of eliminating pixel values which are unrepresentative of their surroundings.

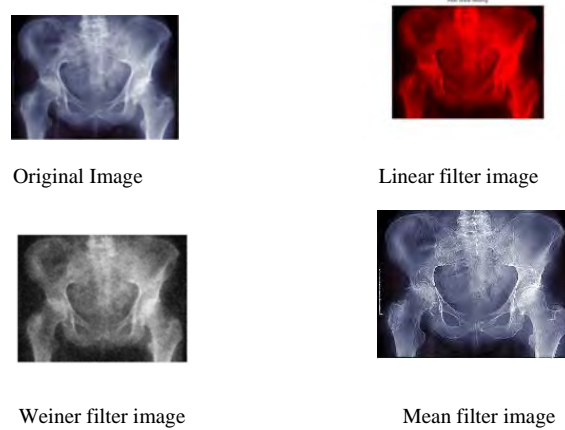


Fig 3: Different type's image filters

Performance Measure of Different Filters

Sl.No	Types of Filter	MSE (Mean Square Error)	PSNR value (Peak Square Noise Ratio)
1.	Weiner filter	5.15	41.01
2.	Linear filter	1.86	45.43
3.	Mean filter	1.03	47.97

Table 1: Performance Measure of MSE and PSNR

Segmentation:

- Canny edge Detection
- Prewitt edge Detection
- Robert edge Detection
- Sobal edge Detection

Edge Detection Techniques can be done using this gradient magnitude:

$$|S| = \sqrt{(S_x)^2 + (T_y)^2}$$

Where |S| is the Gradient magnitude, S_x is the size of original image and T_y is the size of edge detection final image.

Canny edge Detection:

Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edges in images are areas with strong intensity contrasts – a jump in intensity from one pixel to the next. In order to implement the canny edge detector algorithm, a series of steps must be followed. The first step is to filter out any noise in the original image before trying to locate and detect any edges. And because the Gaussian filter can be computed using a simple mask, it is used exclusively in the Canny algorithm. Once a suitable mask has been calculated, the Gaussian smoothing can be performed using standard convolution methods. The localization error in the detected edges also increases slightly as the Gaussian width is increased.

Prewitt edge Detection:

To estimate the magnitude and orientation of an edge Prewitt is a correct way. Even though different gradient edge detection wants a quite time consuming calculation to estimate the direction from the magnitudes in the x and y-directions, the compass edge detection obtains the direction directly from the kernel with the highest response. It is limited to 8 possible directions; however knowledge shows that most direct direction estimates are not much more perfect. This gradient based edge detector is estimated in the 3x3 neighborhood for eight directions. All the eight convolution masks are calculated. One complication mask is then selected, namely with the purpose of the largest module. Prewitt detection is slightly simpler to implement computationally than the Sobel detection, but it tends to produce somewhat noisier results.

Robert edge Detection:

The Roberts edge detection is introduced by Lawrence Roberts (1965). It performs a simple, quick to compute, 2-D spatial gradient measurement on an image. This method emphasizes regions of high spatial frequency which often correspond to edges. The input to the operator is a grayscale image the same as to the output is the most common usage for this technique. Pixel values in every point in the output represent the estimated complete magnitude of the spatial gradient of the input image at that point.

Sobal Edge Detection:

The Sobel edge detection method is introduced by Sobel in 1970 (Rafael C.Gonzalez (2004)). The Sobel method of edge detection for image segmentation finds edges using the Sobel approximation to the derivative. It precedes the edges at those points where the gradient is highest. The Sobel technique performs a 2-D spatial gradient quantity on an image and so highlights regions of high spatial frequency that correspond to edges. In general it is used to find the estimated absolute gradient magnitude at each point in n input grayscale image. This is very alike to the Roberts Cross operator.

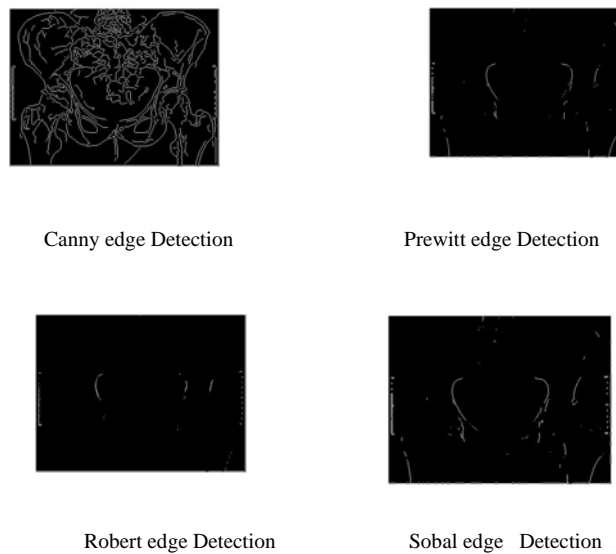


Fig 4: Performance results of different Edge detection

Performance Evaluation of Edge Detection

Sl.No	Different types of Edge Detection	Edge Detection Rate
1.	Canny edge Detection	52.96
2.	Prewitt edge Detection	32.56
3.	Robert edge Detection	31.76
4.	Sobal edge Detection	32.92

Table 2: Performance Evaluation of Different Edge Detection.

7. ANSYS MODELING

ANSYS is a complete FEA simulation software package developed by ANSYS. A finite element model is used to study about the stress of human joints. After the completion of image filtering and edge detection stress is applied to the image. The exact material of the image is used for stress analysis. A Biomedical model has been used for optimizing the lifting posture for minimum efforts. This model is also used to predict the lifting material in every individual human being. This study can be extended for loading of muscles.

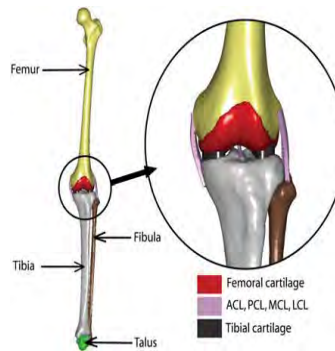


Fig 5: 3D Geometric Modeling

8. FUTURE EXTRACTION

Implementing this methodology the worker compensation will be reduced in the industry and loss of productive man-hours will also be decreased. Approximately one third of all jobs in industry involve MMH The study can be extended to include the loading of the muscles.

9. RESULT AND DISCUSSION

Finite element model can predict the loading behaviour of Human joints for the proposed development. Image processing of Human joints like image filtering, image edge detection also be done. The effort to be taken for the in vivo and in vitro data collection and analysis are reduced multi fold in the finite element modelling.

After the Successful completion of image filtering and edge detection the image is drawn by 2D and 3D CAD model. So that can get fine image. Stress is applied to that image by ANSYS model and the result is compared with the segmented image. The same work is extended to include muscle in future work.

10. CONCLUSION

The study shows the problems among human being by having joints paints using manual material handling. Lifting is considered to be a major cause for low back pain, joints paints and spiral injuries finite elements model is used to study & analyses the success of all human joints using MAT Lab and ANSYS. For the future work the study is extended to include the loading of the muscles.

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