Available online at www.elixirpublishers.com (Elixir International Journal)

Computer Engineering

Elixir Comp. Engg. 119 (2018) 50947-50950

ISSN: 2229-712X

A Study of Human Hip Joint Problems during Manual Material Handling Using Soft Computing Systems

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ARTICLE INFO

Article history:

Received: 19 April 2018;

Received in revised form: 23 May 2018;

Accepted: 4 June 2018;

Keywords

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

ABSTRACT

Importance of ergonomics study in manual materials handling rises from the prospective risks human workplace accidents and injuries. Specifically lifting the materials from one place to other, diverse activities such as pushing, pulling, lowering, and holding, turning and carrying of weights. A risk to many humans are considered to be the prime cause of hip pain, joint impairments, stress and strains, sprains, dislocation of the lumbar spine disc, hip bone fracture, joint inflammation, tear of muscle tissue, contusion, and nerves problem due to often leading activity limitation and workplace accidents. This types of activities leads to increased worker reimbursement and loss of productive man hours. About one third of all jobs in engineering, production and business involve human in Manual Material Handling work. A finite elements model analyze the stresses in human hip joints using Image processing techniques, soft computing like MAT Lab and ANSYS. The more effort is to be taken for data collection and also during finite element modeling. A biomechanical model proposes the development and optimizing the lifting posture for minimum effort. This model is used to predict the lifting capabilities of each and every individuals. Future study can be extended for loading of the muscles strength in human.

1. INTRODUCTION

Human hip joints during manual material handling like lifting the materials is the most important and most complex joints problems in the human body. The hip joints bear the whole weight of the material during lifting. Manual material handling is an expensive public health problem for humans. The governments' organizations and many of the industries including India, USA, UK, Germany, and Japan pay not only for workman's compensation, but also spend more money on their treatment, employee health insurance claims. Manual material handling occurs almost in all business activities like construction, agricultural, hotels and restaurants. Many efforts have been taken to analyze the manual material handling tasks in industry, using detailed design approaches like physiological, psychophysical and biomechanical. The primary assumptions using these control include the incorrect method of handling, the overload is a risk factor for low back pain, and a protective, correct technique can be identified for most of the human work. These approaches are observed differently with reference to human characteristics like age, sex, isometric strength, and survival capacity. Physical characteristics like size and shape of the object handled. Work task Components like movement distance, frequency, duration, and the work practices including posture, methods of load handling and safety functions. As a research subjects, the human hip joints has been thoroughly studied. A biomechanical techniques been proposed to develop optimizing the lifting postures for minimum effort.

2. LITERATURE STUDY

[1] Calin Daniel1,A, Tarnita Daniela2,B*, Popa Dragos3,C, Calafeteanu Dan4,D And Tarnita Dan5,E, January 2016, Virtual Model and Simulation of the Normal and Affected Human Hip Joint, generate a virtual human hip is a main goal for our research team. Also, starting from the normal virtual hip joint and using the important orthopedics information was defined the affected hip joint. All these models were generated in a 3D virtual environment starting with Computer Tomography (CT) scanning images. Using an original method all the scanned CT images were re-defined and re- With motion and geometric Constrains the bio-mechanical assemblies were defined, starting from anatomical information. The normal hip joint and the model of the affected hip were defined and exported to ANSYS, software based on Finite Element Analysis.

[2] Vicky Varghese Cheruparambil, On December 2015, Finite Element Based Design Of Hip Joint Prosthesis, The Work Deals With The Proper Design Of Hip join prosthesis using finite element method. Hip joint is one of the most important weight bearing and shock absorbing structure of the human body. The longevity and functionality of the implant greatly depends on the design of the implant. The shape of the implant is one of most easily recognizable feature in the design of the implant. In the present study, Cobalt-chromium (Co-Cr), Low-carbon stainless steel of type 316(316L SS), titanium alloy (Ti6Al4V), magnesium alloy (AZ91), carbon fiber reinforced PEEK (CF-PEEK) and carbon fiber reinforced PA -12 (CF-PA 12) have been used for implant

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material which are biocompatible. ANSYS finite element package has been used for modeling and analysis of the implant. The implant has been analyzed under static as well as dynamic loading.

[3] T. Lenzi, M.C. Carrozza, and S.K. Agrawal Member, IEEE -2013. The human locomotors adaptation to the action of assistive exoskeletons that provide additional torque at the user's hip, with the goal of reducing the muscle activity during gait while still allowing users to control their joint kinematics. A muscle effort reduction during walking may be desirable for many persons. Several pathologies can decrease the walking ability of affected persons by reducing their.

[4] Faten Abu Shmmala#1, Wesam Ashour, January, 2013 Image processing is very attractive field, mostly image segmentation. Image segmentation refers to the process of partitioning a digital image into multiple segments. To locate tumors and other pathologies, measure tissue volumes, computer-guided surgery, diagnosis, structure treatment planning and study of anatomical or for locating objects in satellite images and it can be used for face and fingerprint recognition, traffic control systems and brake light detection and machine vision.

[5] Raji Nareliya, biomechanical analysis of Human femur bone, Apr. 2011biomechanics is the application of mechanical principles on living organisms. by applying the laws and Concepts of physics, biomechanical mechanisms and structures can be simulated and studied. Finite element method (fem) is widely accepted as a power tool for biomechanics modeling. Irregular geometry, complex microstructure of biological tissues and loading situations are specific problems of the fem in biomechanics and are still difficult to model [10]. Straight beam theory is proposed to calculate stress distributions in the femur due to the body weight and some muscles force given some major simplifying assumptions on the muscles and the joint reactions [5].

3. PROBLEM IDENTIFICATION

Lifting the materials manually by the human affects the joints pain in the human body like foot joints, knee joints, hip joints, shoulder joints, elbow joints, and wrist joints. Due to this problem most of the humans are not supposed to work in all time effectively and efficiently. They often get sick and health problem. In industry the humans are used for lifting materials for various places, floors and upstairs manually. The human get problem with joint during lifting from one place to other pace. Here using finite model the stresses in the human Joints are also analyzed. Biomechanical model supports the identification of work nature and how much load a human being can carry by lifting.

4. DEVELOPMENT OF WORK

Figure 1. Sequential Work.

CT scanned image and MRI scanned Images are taken as original Image as data input and used in Computer Aided Design. Parameters are considered for CAD Modeling in 2D and 3D modeling analysis. Identifying the stress using various the sense loading of material can be found using MAT Lab in the form of Image processing, Image Segmentations. The evolutions of results, addition of work towards Muscles are done in this development of work.

5. RESEARCH METHODOLOGY

CT Scanned Image and MRI scanned image from the medical Lab used as data with their parameters as input and covert in the two dimensional, three dimensional modeling with the help of (CAD) computer aided design tool. Stress after image processing like filtering and segmentation is analyzed with Ansys and the output data is compared with the normal condition. Image processing techniques identifies the exact image of both stressed and unstressed image between original CT Scanned image with 2D and 3D image. The images of various segments are taken as results. The output after segmentation is compared with original image and the exact problem is identified in the joints using this methodology.

6. MATHEMATICAL FORM:

Measure of Body Mass Index can be calculated using their weight, height for both men and woman.

$$\text{Body Mass Index (BMI)} = \frac{\text{Weight in (kg)}}{(\text{Height})^2}$$

If a person is 1.60 m and weights 55 kg

BMI Calculation = 55 / (1.6 x 1.6) = 21.5 <== this person is in the Normal category.

If a person is 1.50 m and weights 65 kg

BMI Calculation = 65 / (1.5 x 1.5) = 28.8 <== this person is in the Overweight category.

BMI List:

BMI	Weight
Less 18.5	Less weight
18.5 – 24.9	Normal
25.0 – 29.9	Overweight
30.0 And Above	Obese

LIFTING EQUATIONS AND ITS FUNCTIONS

Lifting Index (LI)

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

7. PERFORMANCE EXTENT

The Peak Signal to Noise Ratio calculated for the noisy picture and is compared with the original. The value of PSNR and (Mean Square Error) is calculated experimentally.

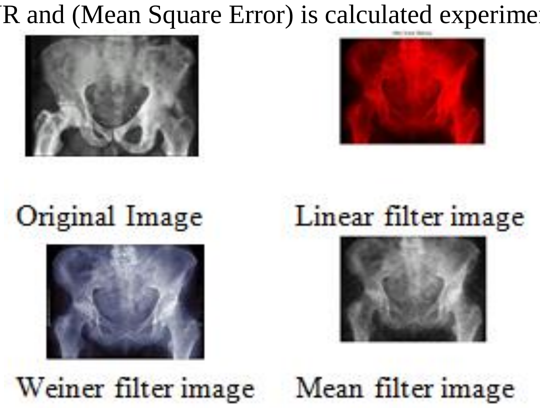


Figure 2. Different types of image filters Performance Measurement of fractured image with different Filters.

$$MSE = \sum_{i=1}^{a} \sum_{j=1}^{b} (\| E_{ij} - F_{ij} \|)^2 / M * N$$

Here E_{ij} is the new original image and F_{ij} is filtered image. M, N is the pixel value of the image.

$PSNR = 10 \log (255)^2 / mse^{10}$

Normal pixel value is 255, the value obtained at the interval [0, 1].

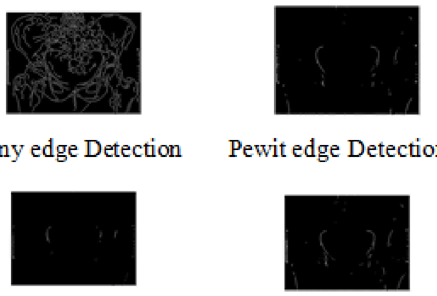
Table 1. Performance Measure of MSE and PSNR.

Sl.No	Types of Filter	Mean Square Error	Value of Peak Square Noise Ratio
1.	Weiner filter	4.10	47.20
2.	Linear filter	1.82	51.20
3.	Mean filter	1.01	55.70

Edge Detection of gradient magnitude for fractured image:

$$|A| = \sqrt{(E_{ij})^2 + (F_{ij})^2}$$

Where $|A|$ is the Gradient magnitude, E_{ij} is the size of original image and F_{ij} is the size of edge detection final image.



Canny edge Detection   Pewit edge Detection

Robert edge Detection   Sobal edge Detection

Figure 3. Results of different Edge detections.

Analysis of fractured image with different Edge Detection

Table 2. Evaluation of Different Edge Detection.

Sl.No	Different types of Edge Detection	Edge Detection Rate
1.	Canny edge Detection	48.72
2.	Prewitt edge Detection	31.88
3.	Robert edge Detection	33.75
4.	Sobal edge Detection	35.31

8. ANSYS MODEL

Finite Element Model was introduced for stress forces that act in human body bones were studied. This method continued to be used more and more frequently, and also it is being used in medical engineering to adapt and to evaluate the endoprostheses. Finite Element Model is a mathematical method, frequently used in engineering for biomechanics or structural analysis. This model is used to find stress in the joints like knee, hip, shoulder, and wrist. Bio mechanical and Bio medical model has been used for optimizing the lifting materials for minimum efforts. Study about ANSYS can be extended for loading of muscles.

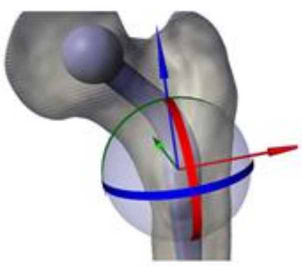


Figure 4. 3. D Geometric Modeling.

Material Properties of Human Bone:
Young's Modulus: 105 MPa
Poisson's Ratio: 0.45
Density: 1550 kg/m3
Mesh Type: Coarse

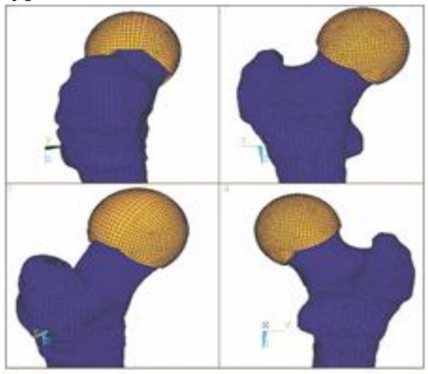


Figure 5. The finite element model of Right femur with the femoral head and articular cartilage – profile, front, oblique and back view.

Computation Modeling

Computation model of our research build using finite element system is ANSYS 10.0. Accurate value for the solution is necessary to create partial models as geometric model, material model, finite element model and loading material. Computer Tomography at SRM Medical Hospital data's are used for the study. From CT sections bones and soft tissues were also separated using image processing like filtering and segmentations. The bone edges were detected using filtering and segmentation. Separated section were exported as a *.iges file format to the finite element system ANYSYS.

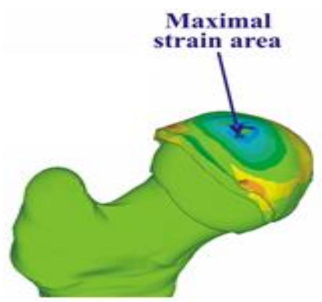


Figure 6. Loading Model

Mechanical Properties of cartilage.

Table 3. Mechanical Properties of cartilage.

Age (Yrs)	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
Strength (Mpa)	4.6	4.6	4.3	4.1	3.4	2.4	1.4	1.2
Maximal Strain(%)	31	28	25	25	20	16	11	9

The Stress and Strain relationship denoted as {α} = [E] {ε}, where: { α } = stress vector = [α x α y α z α xy α yz α xz]E, [E] = elasticity or elastic stiffness matrix or Stress-strain matrix {ε} = total strain vector = [ε x ε y ε z ε xy ε yz ε xz]E

The principal stresses (α1, α2, α3) are stress tools of the cubic equation:

Where: α o = main stress (3 values)

The three main stresses are labeled α 1, α 2, and α 3. The stress intensity α I is the largest of the absolute values of α 1- α 2, α 2- α 3, or α 3 - α 1.

Finite Element Model Results:

The human stress and strain analysis are solved using Finite element Model (FEM). The modeling and finite element analysis of human hip joint and carried out using ANSYS 10.0 of different loading conditions at different people's weight from 50 to 80 kg.

9. FUTURE PROCESS

The human involved in carrying more weight for lifting is reduced in the industry or company by using the Methodology. The production is also increased by more peoples involving in the work. Future Study will be extended using loading material with the same in muscles strength.

10. RESULT AND DISCUSSION

Loading behavior of human hip joints using Finite element model predict the proposed development. Image processing of Human hip joints like filtering, segmentation also be done. The effort is taken is the major role for the data collection and analysis to reduce multi fold in the finite element modeling. After the Completion of image filtering and edge detection the image is drawn by 2D and 3D CAD model. Stress is applied to that image by ANSYS model and the result is compared with the segmented image and also with the original image. The same work is extended to muscle in future work.

11. CONCLUSION

The loading or lifting material and results vary from person to person. It also differ from size of bones, age, height, weight differs in each and every individual. So the material lifting load and stress analysis is advisable before lifting the material manually. The study of human hip joint shows the problems among different human being by having joints paints because of manual material handling. Lifting by more weighted things considered to be a major cause for low back pain, hip joints paints. Knee joints paints and spiral injuries finite elements model is used to study & analyses the success of all human knee joints using MAT Lab and ANSYS. The future study is extended to apply Load in the muscles.

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