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SURVEY ON 3D MODELING OF X-RAY IMAGES USING VIRTUAL REALITY

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Abstract: Virtual reality (VR) is computer-generated stereo visuals that replace the actual world surroundings of a consumer around them. Virtual reality may be supplied to consumers through headsets like HTC Vive, Oculus Rift, and Microsoft's HoloLens or through the camera of a mobile phone. Virtual reality can replace or lessen the consumer's belief in truth in practical and experimental implementations. Virtual reality has been adopted in various industries such as retail, healthcare, science education, and real estate. The motivation behind this project is to enhance the visualize the x-ray in a better way using the technology of virtual reality. The outcome of the project is to input an x-ray image into the system. The system will convert the 2D image to 3D and then the 3D model will be shown in a VR headset. So, the image can be easily visualized in 360 degrees and can get clear visualization from the image. There are many models that measure the bone size for replacement but some are less accurate. Still, our model gives proper measurement and can visualize the x-ray in a VR headset to get more information so this founds an innovation in our proposed model.

Keywords: Canny Edge detection, Image Processing & Digital Image, Digital, X-Ray, VR, Knee Arthroplasty, Google Cardboard.

I. INTRODUCTION

Image processing is a method to perform some operations on an image to get useful information from it. Currently, the use of digital images for diagnosis of diseases in healthcare is very common. X-ray datasets are used for analysis in order to provide a clear diagnosis. The main idea here is to build a system using canny edge detection algorithm that can sketch the edges of knee bone present in a X-Ray image and identify the exact size of the bone for bone replacement by using virtual reality technique. In this system a 3D model of the bone which is to be replaced in place of original bone is to be built.

1.1 MOTIVATION:

The motivation behind this project is to enhance and visualize the x-ray in better way using the technology of AR/VR. We found knee bone replacement problem is very serious in real life. My father had injury of knee and it was very critical that, doctor told us about replacement of the knee bone with the artificial bone was necessary but there is one problem that occur after the replacement of bone is that it is difficult to match the artificial bone size with original bone size as replaced bone is not always accurate in size. So, we were motivated to solve this problem and by implementing VR in our system we will build accurate 3D model of the replacing bone.

1.2 GOALS AND OBJECTIVES:

- To study and identify current VR application and Image processing.
- Creation of adaptive virtual 3D environments.
- To get a 3D model build using the unity tool.
- To create 3D image by use of Caney Edge image processing algorithm with improved accuracy.

1.3 MATHEMATICAL CALCULATIONS:

1.3.1 Noise Reduction-

Edge detection results are very sensitive to image noise, as background computations are primarily based on derivatives. One way to denoise an image is to smooth it with Gaussian Blur. The formula for a Gaussian filter kernel of size (2k+1)×(2k+1) is:

$$H_{ij} = \frac{1}{2\pi\sigma^2} \exp\left(-\frac{(i-(k+1))^2+(j-(k+1))^2}{2\sigma^2}\right); 1 \le i, j \le (2k+1) \quad (1)$$

1.3.2 Gradient Calculation-

The Compute Gradients step finds the strength and direction of edges by computing the gradients of the image using the edge detection operator. The gradient magnitude G and gradient θ are calculated as follows:

$$|G|=\sqrt{I_x^2 + I_y^2}, \quad (2)$$

$$\emptyset(x,y) = arctan\left(\frac{I_y}{I_x}\right) \quad (3)$$

II. LITERATURE SURVEY

Table 1 Literature Survey

SR. NO.	PAPER TITLE PUBLICATION DETAILS	PRE-PROCESSING	FEATURE EXTRACTION AND CLASSIFICATION	ACCURACY	POST PRE-PROCESSING	RESEARCH GAP IDENTIFIED
1	Image Segmentation Using Various Edge DetectionTechniques	Techniques used in the past required extensive computation and are time consuming.	Different techniques used for segmentation of satellite images are: 1. Sobel operator technique 2. Prewitt technique 3. Kiresh technique 4. Laplacian technique 5. Canny technique, 6. Roberts technique 7. Edge maximization technique (emt).	90%	By comparative study it is proved that Kiresh, emt and perwitt techniques respectively are the best techniques for edge detection of satellite image.	Comparative study can be explained & experiments can be carried out for different techniques on different type of images.
2	Edge Detection Techniques for Image Segmentation A Survey of Soft Computing Approaches	An analysis of recent soft computing approaches to edge detection for segmentation.	An overview of edge detection theory for image segmentation using soft computing approaches based on fuzzy logic, genetic algorithms, and neural networks.	86%	A soft-computing approach demonstrates the efficiency of image segmentation.	A combination of techniques can be further used to increase forecast accuracy and efficiency.
3	Implementation of canny's edge detection technique for real world images.	Previously used systems or algorithms had poor accuracy.	Implemented and evaluated different edge detection techniques like: 1. Image capturing 2. Application of gaussian filter. 3. Computing the gradients and directions using sobel operator. 4. Non-maximum suppression. 5. Hysteresis thresholding 6. Robert's cross operator. 7. Prewitt's operator.	92%	The Canny edge detector gives better results compared to others in some positive respects. It is less susceptible to noise, more adaptable, solves the streaking problem, provides better localization, and detects sharper edges compared to others.	This algorithm has been improved and may be improved further in the future. The improved Canny algorithm can detect edges in color images without converting to gray images, and is an improved Canny algorithm for automatic extraction of moving objects in image guides.
4	Edge detection techniques for Image segmentation.	Very large amount of edge detection techniques were available, each technique designed to be perceptive to	The relative performance of various edge detection techniques is carried out with an image by using MATLAB software.	87%	Marr-Hildreth, Log, and Canny Edge detectors produce nearly identical edge maps.	Detecting noise-free and accurate images from original images is a difficult task for the

		certain types of edges.				research community.
5	Edge detection using simple image arithmetic.	Existing methods of edge detection were complex.	The efficiency of the edge detection algorithm using image arithmetic in qualitative and quantitative terms is demonstrated.	90%	Proposed method makes the text in pictures more clear as seen in the image of detected edges, and therefore makes it easier to segment or extract.	This can prove to be a valuable resource in real world applications such as handwriting recognition and text extraction.
6	Edge Detection Based on Improved Sobel Operator.	Conventional Sobel edges are rough and imperfectly detected.	Comparing the sobel operator with several other edge detection operators used frequently and making a further study on the classical sobel operator.	87%	According to comparisons among all kinds of first order operators, the traditional sobel operator make a better improvement.	Its research findings that application system of intelligent decision-making technology in agriculture and animal husbandry.
7	Medical image Edge detection using Gauss Gradient operator.	Superiority of conventional edge detectors like sobel, perwitt, roberts, canny and log algorithm was less	the experiments was carried out on both the berkeley segmentation dataset (bsd) and real medical images, to determine the performance of the gauss gradient edge detector.	90%	Computation time of the gauss gradient approach was slightly higher than the log, canny and prewitt approaches, and in terms of the quality of edge tracing the gauss gradient outperforms the other conventional techniques.	The Gaussian gradient operator can be a powerful tool for telemedicine applications.
8	A novel edge detection method based on efficient Gaussian binomial filter.	Recent image edge detection methods are based on exploiting spatial high-frequency are strictly sensitive to noise, and their performance decrease with the increasing noise level.	A novel approach to image edge detection using dual 2D Gaussian binomial filters.	89%	Proposed approach improved a significant advantage of gaussian binomial filter in terms of speed and efficiency in comparison than other known methods.	A real-time edge detection implementation based fpga (field-programmable gate array) or gpu (graphics processing unit) is an issue that deserves further investigation.
9	An improved prewitt algorithm for edge detection based on noised image.	The traditional Prewitt edge detection algorithm is sensitive to noise.	A Prewitt algorithm [2] for edge detection based on Otsu threshold is proposed in research, where the edge image is denoised by an 8-neighbour window.	88%	The upgraded algorithm greatly improves anti-noise performance and effectively detects edges in randomly noisy images.	Next work is to find a more efficient automatic threshold and a more effective denoising methodto detect edges better.
10	Study and Comparison of Different Edge Detectors for Image	Edge detection has been a key problem in	To compare different edge detection operators and analyze their performance	95%	Canny Edge Detector produces higher object edge	We can carry out more experiments to check

	Segmentation.	image segmentation.	using MATLAB software.		detection accuracy with higher entropy, Psnr, Mse and running time compared to Sobel, Roberts, Prewitt, Zero Crossing and Log.	performance and accuracy.

III. ALGORITHMIC SURVEY

Table 2 Algorithmic Survey

Sr. No.	Paper Title	Author & Year	Algorithm Used	Image Modalities	BONET YPE	Performance Metrics	Advantage and Disadvantages
1	Analysis on Leg Bone Fracture Detection and Classification Using X-ray Images	Myint, et al 2018	Harris corner detection, Decision Tree, KNN	X-Ray Images	Leg Bone	82% accuracy	Fracture location is pointed out by Harris corner points. Decision Tree is used to classify image as fractured or non-fractured. KNN is suitable for pattern recognition and supports to classify transverse, Oblique, and Comminuted fracture types.
2	Automatic detection of fracture in femur bones using image processing	Tripathi, Ankur Mani, et al 2017	Canny edge detection, Support Vector Machine.	X-Ray Images	Thigh bone.	84.7% accuracy	Canny edge detects the bone edge accurately and Sobel operator detects the clear fractured edge. SVM is used to classify image as fractured or non-fractured.
3	Bone Fracture Detection Using Edge Detection Technique	Johari, et al. 2018	Canny Edge Detection	X-Ray Images	Human Bone	87.3% accuracy	Sobel operator with the parameter sigma 4.75 is used to enhance the efficiency of the system and it diagnoses the hairline fracture more effectively.
4	Detecting leg bone fracture in x-ray images	Myint, et al. 2016	Canny Edge Detection	X-Ray Images	Leg Bone	-	Much higher accuracy can be achieved by gaining a better dataset with high resolution images.
5	Bone Fracture Detection Using OpenCV	Kurniawan, et al. 2014	Canny Edge detection using OpenCV	X-Ray Images	Bone	66.7% accuracy	Performance and accuration of the detection system affected by the quality of the image. The better the image quality, better the results.
6	Detection of Bone Fracture using Image Processing Methods	Anu, T. C, et al. 2015	Sobel Edge Detector using GLCM features.	X-Ray/CT images	Leg Bone	85% accuracy	Gray Level Co-occurrence Matrix (GLCM) method is used to extract textural features such

							as entropy, contrast, correlation, homogeneity. Results are evaluated based on GLCM features.
7	Fracture Detection in X-Ray Images through Stacked Random Forests Feature Fusion	Cao, Yu, et al 2015	Random forests for feature fusion	X-Ray Images	Human Bone	81.2% accuracy	This system can be used for various types of fractures over different anatomical regions. SVM and single layer random forests increase the effectiveness. Accuracy could be further improved by incorporating more types of local features.
8	Multiple classification system for fracture detection in human bone xray images	Umadevi, N, et al 2012	Support Vector Machine, Back Propagation Neural Network , KNN	X-Ray Images	human bone	SVM Accuracy – 91.89 BPNN Accuracy— 90.46 KNN Accuracy— 89.76	Experimental results showed that the ensemble model that combines BPNN + SVM + KNN with both texture and shape features significant improvement in terms of accuracy and precision.
9	Bone Fracture Detection and Classification using Deep Learning Approach	D.P. Yadav et al. 2020	Deep Neural Network	X-Ray Images	Human Bone	92.44% Accuracy	In the approach long bone, short bones and flat bones fracture detection has been proposed using deep learning approach. The classification accuracy of the model is 92.44%, Large dataset not used.
10	X-Ray Bone Fracture Classification Using Deep Learning: A Baseline for Designing a Reliable Approach	Leonardo Tanzi et al. 2020	Deep Learning	X-Ray Images	Human Bone	accuracy 94%	achieved results comparable to those of humans in bone fracture classification, number of wrong diagnoses

IV. PROPOSED METHODOLOGY

Below figure is the system architecture of the proposed system.

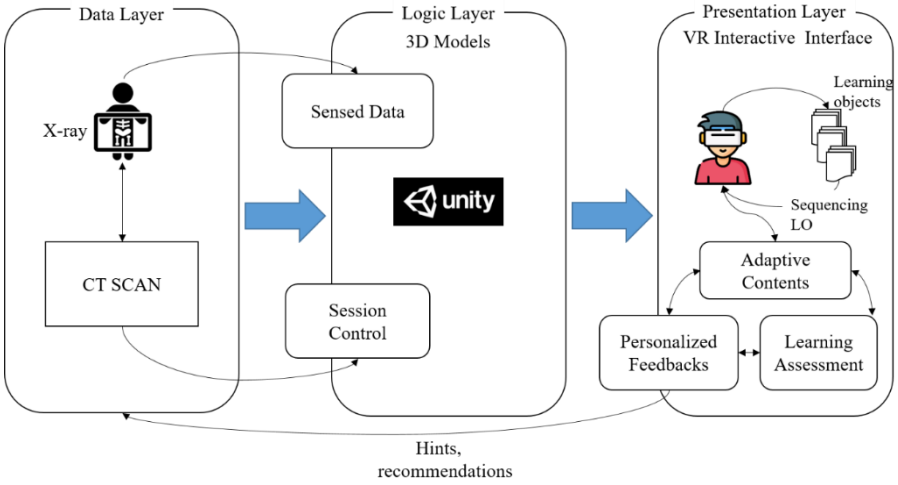

Fig 1: system architecture.

4.1 The proposed system consists of the layers i.e Data layer, Logic Layer, Presentation Layer.

i. Data Layer:

First layer is the Data layer it is the starting phase of the system. In data layer the Knee bone X-Ray image input is given to the system.

ii. Logic Layer:

In this layer the system will find the edges and measurement of the bone using Canny Edge Detection Algorithm. The output of the algorithm is in the form of image that image will be convert into 3D Model.

iii. Presentation Layer:

In Presentation layer the 3D Model is shown in Google Cardboard VR.
By using this system you can get the measurement for bone implant and visualize the bone in more precisely.

4.2 The functional requirement of the system are as follows:

1. Python:

Python is a high-level, general-purpose programming language. His design philosophy uses clear indentation to emphasize code readability. Python is dynamically typed and garbage collected. It supports multiple programming paradigms, including structured programming, object-oriented programming, and functional programming.

2. Unity: -

Unity is a cross-platform game engine developed by Unity Technologies and first announced and released as a Mac OS X game engine at the Apple Worldwide Developers Conference in June 2005. The engine has since been gradually expanded to support various desktop, mobile, console and virtual reality platforms.

3. Google Cardboard SDK: -

The open-source Cardboard SDK lets you create immersive, cross-platform VR experiences for Android and iOS.
Create entirely new VR experiences or enhance existing apps that support VR with essential VR features such as motion tracking, stereoscopic rendering, and user interaction.

4. Google Cardboard Goggle: -

Get it, fold it, take a look inside, and immerse yourself in the world of Cardboard. It's a VR experience that starts with a simple viewer that anyone can create or buy. Once you have it, you can explore the multitude of apps that surround you. And with so many viewers available, you're sure to find one that's right for you.

V. 3D CONVERSION TOOL SURVEY

1. Inkscape:

Inkscape is a free and open source vector graphics editor primarily for creating vector graphics in scalable vector graphics format. Other formats can be imported and exported. Inkscape can render primitive vector shapes and text

2. Blender:

Blender is a free and open source 3D computer graphics software toolset used to create animated films, visual effects, art, 3D printed models, motion graphics, 3D interactive applications, virtual reality and early video games.

3. SelfCAD:

SelfCAD is an online computer-aided design software for 3D modeling and 3D printing released in 2016. It's browser and cloud based. SelfCAD is a mesh-based design program.

4. FreeCAD:

FreeCAD is a general-purpose 3D parametric computer-aided design modeler and software application for modeling building information that supports the finite element method.

5. Smoothie-3D :

Smoothie-3D was one of the first widely used image conversion tools. We recently switched from 100% free to a donation model. You can upload an image and draw an outline around it using the tools provided. The program will then generate a 3D rendering based on the outline image. This can be exported as a Slicer compatible file type such as OBJ or STL. Symmetrical images are recommended, as asymmetrical images can lose detail when tracing.

6. Image to Lithophane:

Image to Lithophane is one of the easiest programs to use with lists. Simply upload your photo, select the shape you want (dome, semi-dome, heart, etc.) and download all new lithophanes for FREE! There are also customization options hidden at the top of the screen.

VI. EXPECTED RESULT

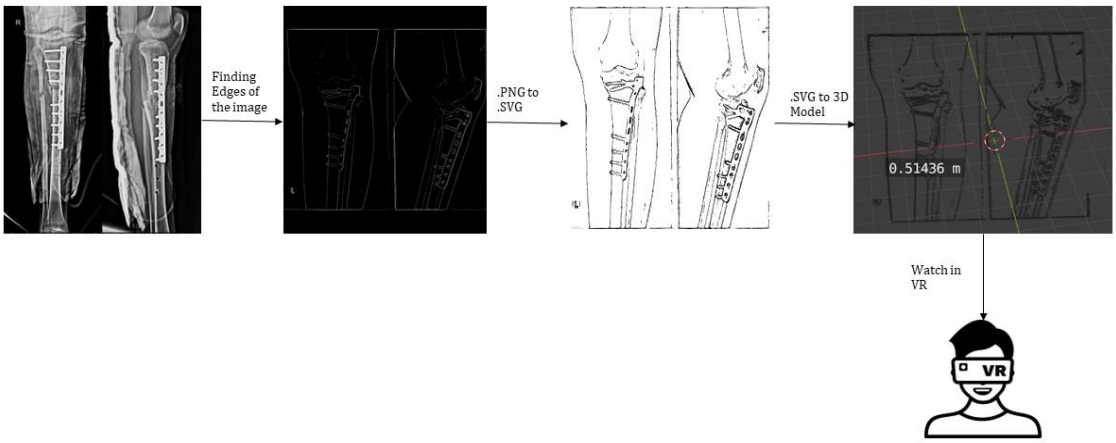

Fig 2: expected result.

VII. CONCLUSION

The digital images of X-Ray for the diagnosis of diseases in healthcare is very common. Digital X-Ray images are used for diagnosing and measuring bone size. But problems occur after the replacement of bone that does match accurately with the original bone size it was very difficult to live with replaced bone that was not accurate in size. Oversizing can result in causing anterior knee pain that can lead to problems such as instability. These techniques are costly and time-consuming. The proposed system has accurately measured the bone size of an X-Ray image that visualizes in VR application. The X-Ray digital data will be given to an application that will find the actual edge of the bone from an X-Ray image. Then the processed image will be converted into a 3D image and the measurement of accurate bone size is visualized in Google Cardboard VR.

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