ROLE OF 3D SCANNING IN VISIBLE SURGICAL SWELLINGS

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Dissertation submitted to

BLDE (Deemed to be University) Vijayapur, Karnataka

In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY

IN

GENERAL SURGERY

Under the guidance of

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SHRIB.M.PATILMEDICALCOLLEGE

HOSPITAL & RESEARCH CENTRE, VIJAYAPUR

KARNATAKA

2020

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LIST OF ABBREVIATIONS USED

3D	**THREE DIMENSIONAL**
TOF	**TIME OF FLIGHT**
CT	COMPUTED-TOMOGRAPHY
MRI	**MAGNETIC RESONANCE IMAGING**
HPR	**HISTOPATHOLOGICAL REPORTING**
CAD	**COMPUTER AIDED DESIGN**
LIDAR	**LIGHT DETECTION AND RANGING**
HIMS	**HOSPITAL MANAGEMENT SYSTEM**
RF	**RADIOFREQUENCY**
CMM	**COORDINATE MEASURING MACHINE**
IR	**INFARED RADIATION**
SNR	**SINGLE DIODE NOISE RATIO**
CW	**CONTINOUS WAVE**
PMD	**PHOTONIC MIXER DEVICES**
APD	**AVALANCHE PHOTO DIODE**
CPU	**CENTRAL PROCESSING UNIT**
DSM	**DIGITAL SURFACE MODEL**
LCD	**LIQUID CRYSTAL DISPLAY**
DSLR	**DIGITAL SINGLE LENS REFLEX**

LIST OF FIGURES:

INTRODUCTION

3D scanning is transforming numerous industries, and the medical industry is no exception. [1,2].

By using 3D scanning and printing technologies, this technology effectively creates items like prostheses, custom implants, dental appliances, and prosthetic limbs that look and feel like the actual thing. [3,4].

To create 3D images of a patient's interior organs, X-rays, ultrasounds, computed tomography (CT) scanners, and magnetic resonance imaging (MRI) are frequently employed.

The new scanners are safe, rapid, and convenient for measuring an individual's body shape, size, texture, colour, and skin-surface area precisely without making physical contact. [5,6].

The 3D file of the object that is produced after scanning can be digitally stored and edited in a computer to the desired shape and dimensions.

3D-scans have been utilised in surgery for the patient consultation, counselling, choice of therapy, and digital documentation. These 3D digital file data can be printed using different 3D printing technologies.

Surgery cases and procedures will benefit from 3D scanning since it will help surgeons with pre-, post-, and intraoperative 3D analysis, therapy selection, consultation, and documentation.

New 3D cameras are portable, lightweight, user-friendly, and small enough to bring to any medical facilities.

NEED FOR THE STUDY

• Different scanning technologies, including X-rays, MRI, CT, and ultrasound, are widely used in the medical industry. These methods do have problems, however they are useful for revealing information about the internal organs.

• However, there remains a gap in the information available for the outside bodily components, which 3D scanning technology can now fill. it is faster at creating and iterating designs.

• For the pre-, intra-, and postoperative documentation of the human body, 3D surface imaging provides an objective, non-invasive, and radiation-free diagnostic tool.

• This technique allows for the generation of a result in which the texture capture is enabled with a full depiction in true colour of the target tumour or swelling.

Intraoperative specimen scanning will assist the pathologist in histopathology reporting. Preoperative counselling using the scanned images for swellings are of great help, for example: like unseen swellings at the back of the neck and thorax.

• It brings up new, many, and diverse applications in surgery, which is concerned with reconstructing and improving the human body's damaged form, surface, and function following tumours or other pathologies.

• As a result, it was suggested that this study be undertaken in order to demonstrate the tremendous potential of 3D imaging using more modern mobile and hand-held scanning instruments for new surgical methods.

AIM AND PURPOSE OF THE STUDY

• By using this 3D scanning approach, clinicians will be able to provide patients with the finest care possible while minimising risks and increasing rewards.

• The following are the study's objectives:

1. Lead time: Preoperative scan, intraoperative specimen scan, and postoperative scan time (from start to finish of scanning).

2. To research operational adaptability.

3. The generation of data, documentation, and application of patient counselling methods.

4. 3D picture annotation in HPR.

REVIEW OF LITERATURE

3D scanning is a method for precisely converting a physical object's size, form, and dimensions into a digital, three-dimensional representation.[19]

The "picture" created by a 3D scanner indicates the exact distance from each point in the image to a surface. This makes it feasible to locate each point in the image in three dimensions.[16]

The similarities between cameras and 3D scanners are numerous. They have a spherical field of vision like most cameras, and like cameras, they can only gather data on surfaces that are not blocked.

A camera captures surface colour information, but a 3D scanner records surface distance relevant data inside its range of view.

A number of technologies are available to digitally collect the shape of a 3D object. The majority of sensor types, including optical, acoustic, laser scanning, radar, thermal, and seismic, are compatible with the approaches.

In order to swiftly create point cloud data with a high degree of precision, 3D scanners precisely measure minor characteristics and record free-form objects.

Real-world objects or environments are analyzed via 3D scanning to learn more about their shape and maybe appearance (e.g. color). 3D Digital models can then be created using the collected data.

For instance, employing industrial computed tomography scanners, structured-light 3D scanners, LiDAR, and 3D time of flight scanners, digital 3D models can be produced without endangering testing.

The primary function of a 3D scanner is to gather data about an object.

• a thing;

• a setting (as a room);

• a person (3D body scanning)

A 3D scanner is regularly used to produce 3D models. This 3D model is comprised of a point cloud, polygon mesh, or geometric samples taken from the surface of the subjects.

These places can then be used to determine the subject's form (a process called reconstruction). The colours or textures of the surface can also be ascertained if colour data is captured at each location.[20]

A non-invasive, radiation-free, and objective diagnostic tool is provided by 3-D Surface Imaging for the pre- and post-operative documentation of the human body.

The phrase "three-dimensional (3D) imaging" has been used to describe methods that may interpret real interior 3D data by gathering volumetric pixels (or voxels) of the measured target since the first reports of computed tomography (CT) in 1967 and magnetic-resonance imaging (MRI) in 1971.

The term "3D surface imaging" refers to an imaging procedure that measures and analyses surfaces (in x, y, and z coordinates) in a 3D space as opposed to CT and MRI.

Since the 1940s, stereophotogrammetry, image-subtraction methods, moire' topography, liquid-crystal scanning, light-luminance scanning, laser scanning, structured light, stereolithography, and video systems have all been used to assess the complexity of an object's surface.

Generally speaking, laser scanning devices have been used for construction and quality control, particularly in the automotive industry, for decades. This information has been applied to the field of surgery for preoperative planning of procedures in conjunction with CT imaging.

The development of 3-D cameras nowadays is comparable to that of smartphones in that they are small, light, portable, and even more user-friendly.

Utilization of 3-D imaging for the sole purpose of documentation in various applications with new mobile devices

They could help surgeons with pre-, post-, and intraoperative 3-D analysis, therapy selection, consulting, and documentation.

These devices offer 3D analysis with encouraging outcomes, but the most have not been used in clinical practise due to laborious procedures, variable image quality, and unpredictably high costs.

In the past ten years, improvements in optical technologies, such as structured light and stereophotogrammetry, have reduced the time needed to produce exact 3D surface images, handle enormous amounts of data rapidly, and be more adaptable to patient procedures.

Surgery planning, outcome assessment, and patient communication have all reached new levels because to the rapid advancements in 3D scanning technology during the past ten years.

The technologies used in 3D surface-imaging systems and their intended field of use vary between the different industries.

The medical institutions uses a variety of scanning methods, including X-rays, CT, MRI, and ultrasound.

These techniques are quite useful for giving information about the inside organs. The information that can be acquired on the external bodily parts still has a gap, which is now covered by 3D scanning technology.

It is used to measure a patient's body part specifically as well as their overall size, shape, and skin surface area.

Medical information varies from patient to patient, hence 3D imaging techniques that generate digital 3D models are used to create 3D digital images. We can enhance patient care by integrating digital models with virtual reality and holographic technology.

The main limitation of this technology is that it can only scan the outside of a body part, model, or other object.

In the past, doctors would diagnose patients, decide on their treatment options, and evaluate their general health using hand measures or specialised equipment.

Today, 3D internal images of a patient's body are produced using X-rays, computed tomography (CT) scanners, ultrasound, and magnetic resonance imaging (MRI)

The advent of 3D scanners, which can properly assess a person's body shape, colour, size, texture, and skin surface area, has given rise to a new field of clinical use. A 3D scanner is incredibly capable of taking 3D measurements without making contact with the object.

demonstrating the great potential of 3-D imaging for new surgical techniques when combined with increasingly advanced handheld and mobile scanning technology.

These platforms could significantly affect the use of evidence-based

The documentation and assessment of a patient's pre-, intra-, and postoperative surgical states will have an impact on patient consultation and treatment options for common surgical indications in the future.

3D scanners take a precise image of a three-dimensional part.

The digital data that was generated is compatible with the software that was used for creation, testing, and inspection.

Using software that automatically gathers measures while scanning, this technique eliminates transcribing and measurement errors.

Deep understanding of the interior architecture of the body is now possible thanks to recent diagnostic procedures made possible by cutting-edge technologies.

Magnetic resonance imaging (MRI), computed tomography (CT), X-rays, and ultrasound all offer a platform for researching anatomy and physiology. These methods also aid in the monitoring and diagnosis of illnesses.

It eases anxiety and discomfort because it is less invasive than the standard scanning method. It enhances quality and reduces product waste by better assessment.

The 3D scanner can eliminate the need for manual measuring and speed up implant production.

Anatomical models, gloves, implants, prostheses, and other specialised applications can all be made using point cloud data from 3D scanners, as well as accurate form and colour recovery.

In addition to applications requiring human body imaging, such as security, fashion, athletic performance, and medicine, the digital data can be used for the creation of holograms.

The manufacturing, medical, and surveying industries employ the scanning device's high-quality data.

Famous historical and cultural places are also used to build 3D models using this method. Any object can be quickly reproduced in 3D and inspected from any angle.

Similar to how a camera works, a 3D scanning equipment works by combining numerous photographs to produce a virtual 3D model.

The three fundamental techniques for producing three-dimensional images are photogrammetry, stereo vision, and fringe projection.

It creates a 3D digital file by combining numerous pictures to generate a model.

A wide range of technologies are being developed to collect data from the patient's body, equipment, or models. The earliest human body scanning technologies are covered in the subsections that follow.

X-rays

In order to produce a medical image, X-rays are required. This technique enables beams to pass through soft tissue, such as skin and organs, which cannot withstand high-energy radiation.

Despite the fact that radiation is absorbed by solid things like bones, X-rays can nevertheless show the state of the bone.

Similar to a camera, X-ray films likewise produce X-rays depending on the exposure region.

It is used by dentists for a variety of medical procedures as well as patient diagnosis. An X-ray is a type of light ray, much like the common visible light we all experience every day.

The main difference between X-rays and visible light is the X-rays' wavelength.

CT SCAN:

A CT scan involves directing an X-ray beam at the body and moving it in an arc while collecting several pictures.A CT scan can reveal the tissue density within solid organs.

It provides precise information and high-resolution photos of the body's internal organs, such as the reproductive system, inner ear, eyes, sinuses, heart, lungs, neck, spine, and shoulder.

MRI:

An MRI uses a powerful magnetic field and radio frequency pulses to provide an in-depth image of the bone, soft tissues, organs, and other internal parts of the body.

Healthy tissue can be distinguished from diseased tissue using MRI. It assists in providing an accurate diagnosis.

ULTRASOUND:

Ultrasonography uses sound waves to produce images of the inside structures of bodily organs.

It helps identify the cause of pain, inflammation, and infections in the internal organs of the body.

It is used to help diagnose cardiac issues, guide biopsies, and assess damage after a heart attack.

A safe, non-invasive, and radiation-free medical procedure is ultrasound.

Other terms for ultrasonic imaging include sonography and ultrasound scanning.

IMPLEMENTING 3D SCAN

Through 3D scanning, free-form three-dimensional data is generated, which can appear as a point cloud or a triangle mesh.

A common reference system is used to incorporate data from photos or scans to produce a comprehensive model known as alignment. a projector displays a series of light patterns onto an object, which the camera then utilises to take a photo of, to record the image utilising structured light in a 3D format.

In contrast to X-rays, CT scans, MRI scans, and ultrasound, 3D scanning provides information about the body's external surface whereas CT scans, MRI scans, and ultrasound technologies provide information about the inside geometry of the body component, including bone, tissues, and other organs.

All of these technologies are used to meet various medical imaging requirements and aid in the identification of a variety of diseases and conditions.

Due to 3D scanning, several businesses, including the medical sector, are undergoing change.

This method efficiently produces products like prostheses, dental appliances, custom implants, and artificial limbs that feel and look authentic by utilising 3D printing technologies.

It is simple to create 3D objects on a printer using data from a 3D scanner and a 3D digital file.

The goal of the medical industry is to build complex medical models quickly and inexpensively while simultaneously reconstructing a skull, speeding up surgery, getting precise results, and improving implant quality.

COMPLEXITY

Traditional manufacturing methods are unable to accommodate the complex and organic shapes of the skin. It takes a few days or a week to complete the process.

Using 3D scanning technology, any model may be quickly captured.

Any complex medical model can be scanned and printed using these techniques, including thin scaffolds that were expertly built.

Utilizing 3D scanning technology, model design is now easily achieved, which was previously not possible with other tools available.

LEAD TIME

One of the distinguishing features of 3D scanning is the capacity to produce and iterate designs more quickly.

It is an essential component of a medical equipment that aids in patients' quicker success.

DATA GENERATION

With today's 3D imaging, patient-specific scan data from 3D scanning is easily accessible.

The information is precisely represented as a collection of points, resulting in a 3D surface that would be difficult to measure otherwise. The techniques CT, X-rays, ultrasound, laser scanning, and MRI can also be used for data generation.

This technology is rapid and accurate, and it can measure a range of objects from the outside. It provides accuracy up to 30 metres.

From the scanned data, the information is converted to standard triangulate language (STL) format.

For diagnostic purposes, the device scans the outside; the same data can also be used to provide details about geometrical aspects.

A 3D scanning device is suitable for medical applications today and in everyday practise.

An exact model can be made at a reasonable cost. The 3D file of the object created by the computer can be digitally saved and modified to assume the required shape and dimensions.

Finally, this 3D digital file's data can be printed utilising various 3D printing methods.

In a wide range of different industries, such as video games, jewellery, animation, aerospace, and autos, 3D scanners are widely used professionally.

This technology can scan both big and small items, giving artists a wide range of possibilities. It might enable us to realise our amazing ideas. It enhances its application in the film industry and video games.

3D scanners have the ability to greatly improve the production of physical models and treatments when correctly linked with additive manufacturing techniques for printing and inspection.

It is becoming more and more time and cost-effective with increased flexibility.

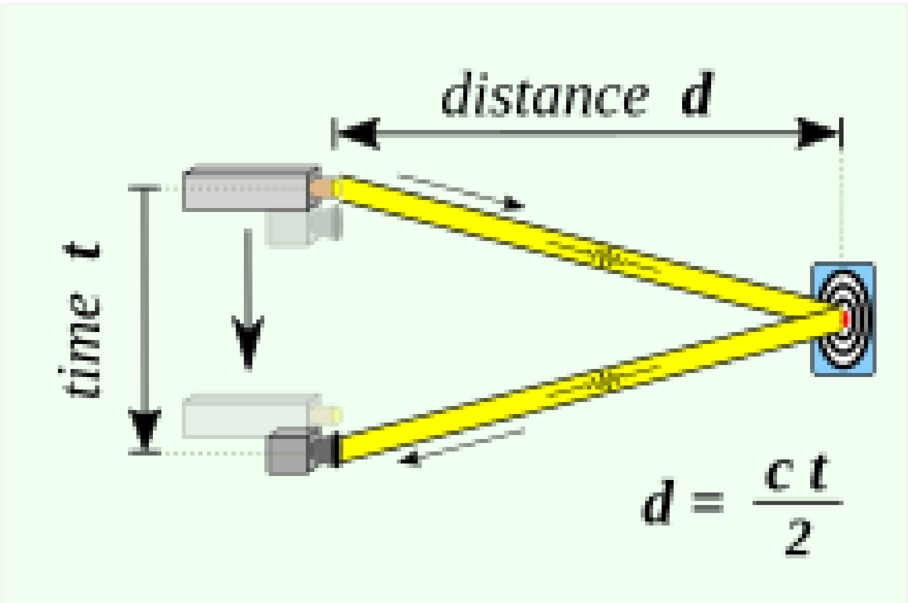
The fact that 3D scanning accurately captures surface data and is appropriate for use in research and development serves as the main argument for its application in the medical field.

To merge these scans into a complete 3D model, an alignment or registration technique must be used to bring them into an unified reference system.

The 3D scanning process refers to the complete procedure, from the first range information to the finished model.

A range imaging camera system known as a **time-of-flight camera (ToF camera)** employs time-of-flight techniques to calculate the separation between the camera and the subject at each point in the image. by calculating the time it takes for a laser or LED-generated artificial light signal to travel round-trip.

Instead of doing it point-by-point like scanning LIDAR systems do, a broader group of scanner less LIDAR, including laser-based time-of-flight cameras, records the entire scene with each laser pulse.



An object's shape is digitally captured in the real world using 3D laser scanning, a non-contact, non-destructive method. From such a surface of an object, three-dimensional laser scanners produce "point cloud data" of data.

In other words, 3D laser scanning is a technique for accurately capturing the dimensions, shape, and size of a physical object and representing it digitally in three dimensions.[23]

To swiftly and precisely create point clouds, 3D laser scanners examine minute features and record free-form structures.

When measuring and analysing curved surfaces and complex geometries that require a vast amount of data for an accurate description and when doing so is impracticable with the use of a touch probe, 3D scanning is the best option.

A 3D scanner acquires information about the subject-matter and its surrounds (such as the room in which it is located). if a person is seated close to a 3D-scannable object.

Time of flight, triangulation, phase shift, and stereo imaging are the four primary techniques utilised in 3D laser scanning.

The numerous 3D scanning methods and underlying ideas are as follows:

• the use of LASER triangulation technology for 3D scanning.

• a method for using structured light to scan 3D objects.

• Photogrammetry; contact-based three dimensional scanning technology.

• Laser-pulse-based 3D scanning technology.

The two categories they fall under are "contact" and "non-contact." Active and passive non-contact methods are the two main subcategories. A great variety of technologies is present in each of these fields.

There are mainly two types of contact 3D scanners:

Coordinate measurement machines, or CMMs, frequently come with three perpendicular moving axes and a touch probe that is positioned on the Z axis.

As the touch probe circles the component, sensors on each axis capture the touch probe's position to provide XYZ coordinates. Modern CMMs have five axes, with the additional two axes being provided by spinning sensor heads.

A CMM provides 3D measuring accuracy down to the micron level.

The largest advantage of a CMM, beyond accuracy, is its capacity to run autonomously (via CNC) or as a human probing tool. It's a negative.

polar sensors are often located at each joint of multi-segmented, articulated arms.

The location of the articulated arm's end is calculated using complex math and the wrist rotation angle of each joint as the articulated arm circles the component, in accordance with the CMM.

Additionally, both modern CMMs and articulated arms can be equipped with non-contact laser scanners in place of touch probes.

NON-CONTACT ACTIVE: Active scanners that are NON-CONTACT emit some kind of radiation or light, then they can detect the radiation's reflection off of or passing through an item. Potential emissions include things like light, ultrasound, and x-rays.

TIME OF FLIGHT:

The duration of the flight is referred to as a laser 3D scanner when it actively scans objects by probing them with laser light. A time-of-flight laser range finder is at the core of this kind of scanner. The time it takes for a light pulse to complete one full rotation is used by the laser range finder to compute the distance to a surface.

The time it takes for the light to reflect from a laser pulse and reach a detector is measured.

The distance traversed by the light, which is double the distance between the scanner and the surface, can be calculated from the round-trip time because the speed of light, C, is known. Distance matches C if T is the round-trip time. T/2.

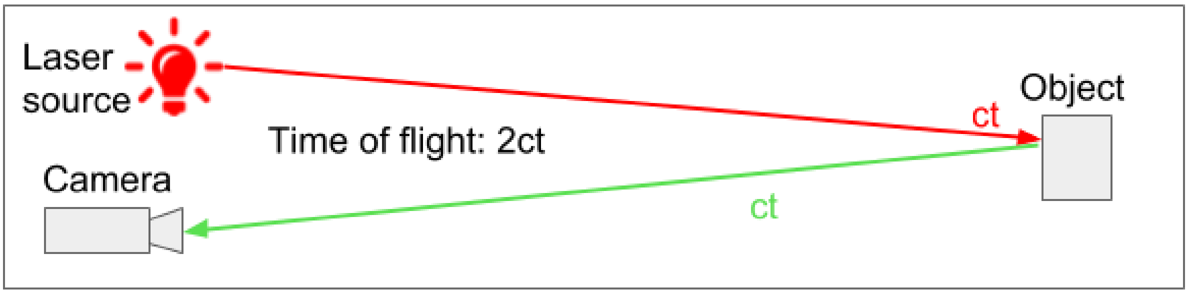
A time-of-flight 3D laser scanner's accuracy is based on how well we can forecast the T time: The average time it takes for light to move one millimetre is 3.3 picoseconds. Only one point inside its area of vision can be estimated by the laser rangefinder as to how far away it is.

The range finder's field of vision is moved about to scan various areas as the scanner scans its entire field of view one spot at a time. Either the laser range detector itself can be rotated, or a system of spinning mirrors can be used to modify the detection and ranging finder's view direction. Since mirrors are far lighter and can be spun more quickly and accurately, the latter method is typically used. Time-of-flight 3D laser scanners can measure a variety of objects.

Time of flight or laser pulse scanning generates a 3D model scan by measuring how long it takes a laser beam to reach an item, bounce off of it, and then return to the laser's source.

The technique is widely used in range imaging camera systems or 3D cameras. Time-of-flight technology is a very high-end alternative that is frequently used to scan large environments and structures, despite the fact that it can be expensive.

Each pixel in a depth image created by Time-of-Flight (ToF) cameras encodes the distance to the associated point in the scene.



These cameras can be used to immediately evaluate three-dimensional structure without the use of traditional computer-vision approaches. Numerous practical applications for this ground-breaking sensing method include 3D reconstruction, robot navigation, and human-machine interfaces.

Using ToF cameras, the phase-delay of reflected infrared (IR) light is calculated. There are further techniques for determining depth, such as visual triangulation assisted by the projection of an IR structured-light pattern onto the scene.

These devices have several applications in common with TOF cameras, much like the Kinect. A raw depth image contains both systematic and non-systematic bias due to the special sensor architecture of the ToF camera, which must be eliminated for accurate depth imaging.

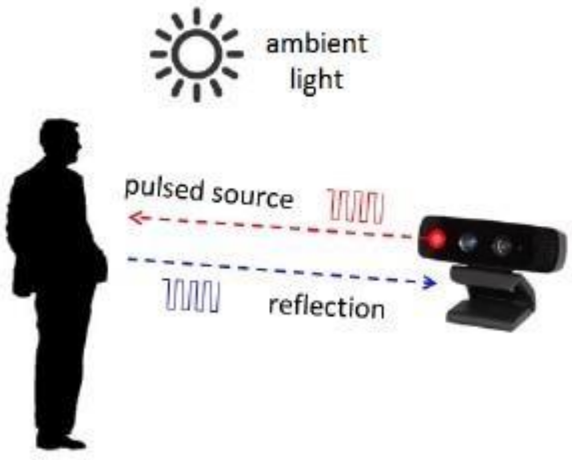
A 3D time-of-flight (TOF) camera illuminates the environment using a modulated light source, then examines the reflected light. By measuring the phase difference between the illumination and the reflection, one may determine the distance.

The illumination is often produced by a solid-state laser or LED that generates light in the near-infrared (850 nm) range, which is not visible to human eyes.

An image sensor designed to respond to the same spectrum of light collects the light, converting the photonic energy into an electrical current.

Be aware that the ambient and reflected light that enters the sensor come in two parts. Distance (depth) information is only present in the reflected component. As a result, a high ambient component reduces the signal to noise ratio (SNR).

To detect changes in the phase between the illumination and the reflection, a continuous-wave (CW) source that is often a sinusoid or square wave modulates or pulses the light source.



Imagers for direct time-of-flight :

The direct time-of-flight needed for a single laser pulse to depart the camera and reflect back onto the focal plane array is measured by these instruments.

This technique, sometimes known as "trigger mode," records entire 3D sceneries with a single laser pulse, capturing comprehensive spatial and temporal data. This enables quick scene information capture and quick real-time analysis.

The 3D Flash LIDAR cameras from Advanced Scientific Concepts, Inc. are Direct TOF vision systems that are tailored to certain applications (such as aerial, automobile, and space).

Their method makes use of InGaAs Avalanche Photo Diode (APD) or PIN photodetector arrays that can image laser pulses with wavelengths ranging from 980 nm to 1600 nm.

A time-of-flight camera's components are as follows:

• **Lighting source**: It brightens the environment. Only LEDs or laser diodes can be used for RF-modulated light sources with phase detector imagers since they can modulate light at high speeds up to 100 MHz. For Direct TOF imagers, one pulse (e.g., 30 Hz) per frame is employed. To make the illumination inconspicuous, infrared light is typically used.

• **Optics**: A lens collects reflected light and projects images of the surrounding area onto an image sensor (focal plane array). Only light of the same wavelength as the illumination source is allowed to pass through an optical band-pass filter. This lessens noise and suppresses irrelevant light.

• **Image sensor:** The TOF camera's beating heart. Every pixel calculates the amount of time it took for a beam of light to go from the illumination source (a laser or LED) to the target and back to the focal plane array. Timing is done in a variety of ways; see Types of devices above for further information.

• **Driver electronics:** High speed signals must be used to synchronise and operate both the lighting unit and the image sensor. For a high resolution to be achieved, these signals must be extremely exact. For instance, the distance varies by 1.5 mm if the signals between the lighting unit and the sensor vary by only 10 picoseconds. When compared: Currently available CPUs can run at speeds of up to 3 GHz, or 300 ps per clock cycle.

PRINCIPLE-

A time-of-flight camera's most basic design employs light pulses or a single light pulse. A brief period of time is spent turning on the lighting; the resulting light pulse brightens the scene and reflects off of the nearby items.

The reflected light is collected by the camera lens and imaged onto the focal plane array or sensor. The entering light encounters a delay based on distance.

These brief intervals demonstrate the importance of the lighting unit as a system component. Such brief pulses can only be produced with special LEDs or lasers.

An individual pixel is made up of a photosensitive component (e.g. a photo diode). The entering light is changed into a current by it.

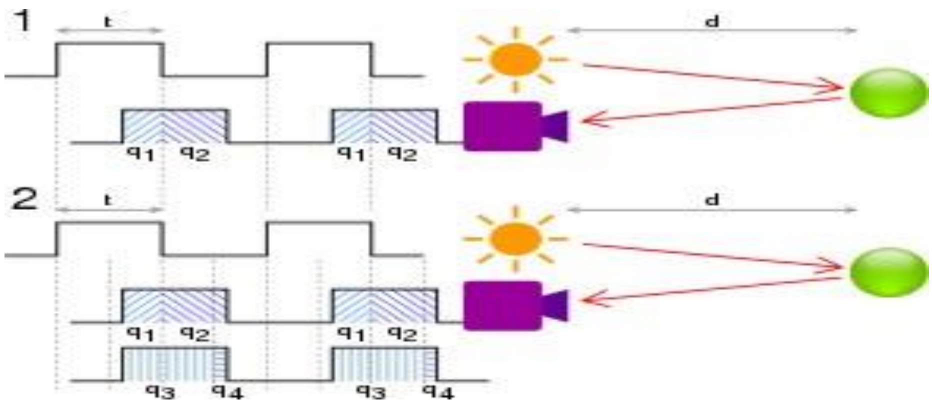
Fast switches that are attached to the photo diode in analogue timing imagers route the current to one of two (or more) memory elements that serve as summation elements, such as a capacitor. Each photodetector pixel in digital timing imagers is coupled to a time counter that can run at several gigahertz and stops counting when light is detected.

Background light increases the amount of signal that the memory elements receive. The measurement of distance would be affected by this. The entire test can be repeated with the illumination turned off to remove the background component of the signal. The outcome is also incorrect if the items are farther away than the distance range. A second measurement with the control was made here.

For direct TOF imagers, such as 3D Flash LIDAR, the laser emits a single brief pulse that lasts between 5 and 10 ns. By immediately recording the pulse and routing this timing onto the focal plane array, the T-zero event (the moment the pulse leaves the camera) is determined.

The return time of the returning reflected pulse on the various pixels of the focal plane array is compared using T-zero. Each pixel reliably outputs a direct time-of-flight measurement by measuring the time difference between T-zero and the captured returning pulse.

The round trip of a single pulse for 100 meters is 660 ns. With a 10 ns pulse, the scene is illuminated and the range and intensity captured in less than 1 microsecond.



Operating principles for time-of-flight cameras

In the pulsed technique (1), the distance, d = c t/2 q2/q1 + q2, where q1 is the accumulated charge in the pixel when light is emitted and q2 is the accumulated charge when it is not, and c is the speed of light.

d = c t/2 arctan q3 - q4/q1 - q2 is the formula used in the continuous-wave approach (2).

Triangulation-

Triangulation-based 3D laser scanners are active scanners in the sense that they use laser light to scan their surroundings.

In terms of time-of-flight 3D laser scanning, a laser is used to illuminate the target, and a camera is used to find the laser dot.

Depending on how close the laser is to the target surface, the laser dot's position changes within the device's field of view. This process is referred to as triangulation because the laser emitters, the camera, and the laser dot form a triangle.

The triangle's one side's length as well as the separation between the laser emitter and camera are both known. It is also known what angle the corner of the laser emitter is.

By observing where the laser dot is situated within the camera's field of vision, it is possible to calculate the angle of the camera corner. The triangle's size, shape, and location of the laser dot corner are all determined by these three bits of information.

Trigonometric triangulation is a technique used by laser-based 3D scanners to precisely record a 3D geometry as millions of points. In order to capture an object's reflection, laser scanners project one or more laser lines onto the target surface. One or more sensors then pick up the reflection.

The sensors' location in relation to the laser's source is known. The laser light's reflection angle can then be determined to get precise point measurements. There are many different designs and models of laser scanners.

They consist of single point long-range trackers, arm-based trackers, portable handheld units, and trackers with a CMM as a foundation.

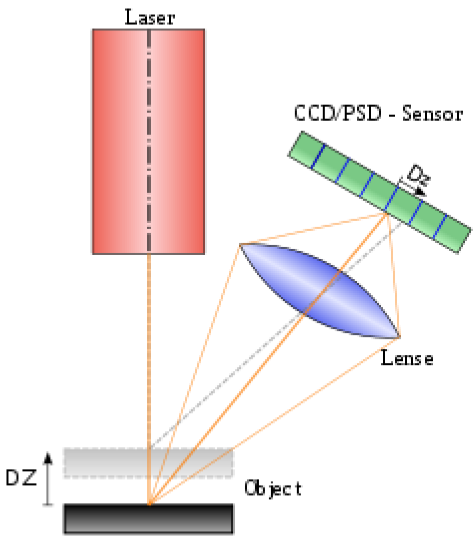
Benefits of 3D Laser Scanners

· Can scan tough surfaces, such as shiny or dark finishes

· Lesser sensitive: to change of light conditions and ambient light

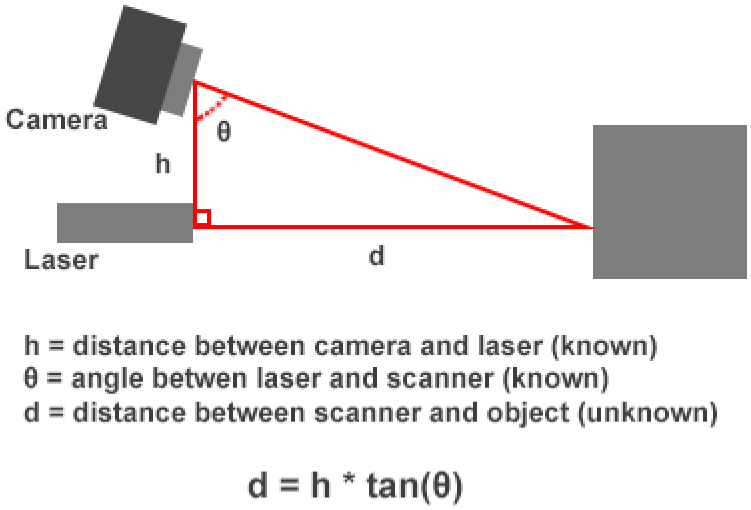
· Portable

· they are simple design, easy to use, and low cost.



Principle of laser triangulation sensor.

Laser triangulation 3D scanning technology: In this category, the laser scanner which projects a laser beam on a surface and helps in measurement of the deformation of the laser ray.



HAND HELD LASER SCANNERS –

A sensor (typically a charge-coupled device or position sensitive device) used by portable laser scanners measures the distance to the the object's surface following projecting a laser dot or line onto it, creating a three-dimensional image. Since information is gathered in relation to an internal coordinate system, it is vital to be aware of the scanner's location in order to collect information while it is moving.

The scanners may determine the position through using either external tracking techniques or reference features on the surface being scanned (usually adhesive reflecting tabs, but natural features have also been employed in research work).

External tracking frequently takes the form of a laser tracker (to provide the sensor location) with an integrated camera system (to establish the orientation of the scanner) or usage of a photogrammetric solution using three or more cameras to provide all six degrees of freedom of the scanner.

Both techniques commonly employ infrared light-emitting diodes mounted to the scanner, which are only detectable to the camera(s) via filters resistive to ambient light.

Information is gathered by computers, who then store it as three-dimensional data points.

After processing, this data can be turned into a triangulated mesh and then a computer-aided design model, which is typically represented by irregular, rational B-spline surfaces.

Either an LCD projector or another reliable light source is used to project the pattern onto the target. In order to determine the distances between each point in the field of view, a camera that is somewhat offset from the pattern projector examines the pattern's shape.

There are still a lot of research articles produced every year in the domain of structured-light scanning, which is still highly active. As structured light patterns that address the correspondence issue and enable error monitoring and repair, perfect maps have also shown to be helpful.

Structured-light 3D scanners have the advantages of speed and accuracy. Structured light scanners scan a number of points or the entire field of vision at once as opposed to one point at a time.

The issue of distortion from motion is diminished or eliminated by quickly scanning a complete field of view. Some systems now in use can scan moving objects in real time.

Using digital fringe projection and phase-shifting techniques, a real-time scanner was developed to record, recreate, and shows greater details of dynamically deformable objects (such facial expressions) at a picture rate of 40 frames each second (particular types of structured light approaches).

This system allows for the application of various patterns, and the frame rate for data processing and capture is 120 frames per second.

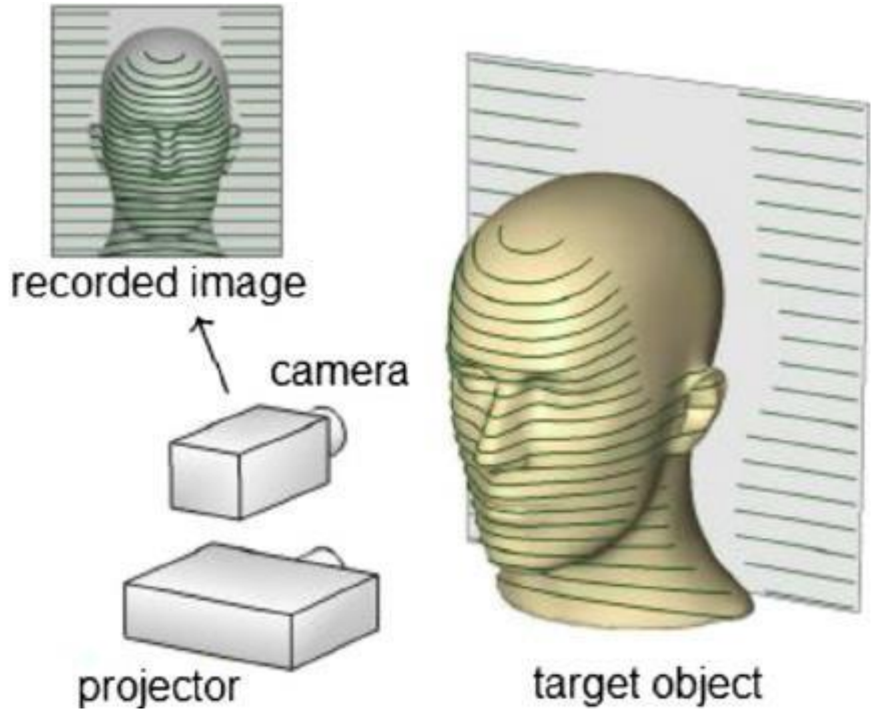
Additionally, it has the ability to scan isolated objects, such two moving hands. Speed improvements have been made that could approach hundreds to thousands of frames per second by applying the binary defocusing technique.

For a decent 3D scan, structured light scanning is less dependent on texture variance.

In this technique, a projector is utilised in place of one of the cameras used in stereo vision and laser scanning to project various light patterns onto an item's surface and record how the object distorts those patterns.

The known camera position and data from the light pattern hitting the object are used to construct model points. The pixels on the projector and the pixels on the camera must exactly match for the system to work.

Structured light scanning is employed in remote environment recognition, reverse engineering, design, and production (two cool examples are mapping the seafloor and the inspection of railway tunnels).



Structured lighting Historically, 3D scanners, also referred to as "white light" 3D scanners, used a projected blue or white LED light.

These 3D scanners shine a light pattern onto a bar, block, or other contour object.

The 3D scanners have one or even more sensors that scan the edges of those patterns or structural components in order to determine the object's 3D shape.

The distance between the sensors and the light source is determined using the same trigonometric triangulation technique as laser scanners. Scanners for structured light can be portable or mounted on a tripod.

Benefits of Structured light 3D Scanners

- Very quick scan times—as little as 2 seconds per scan—and high resolution—up to 16 million points each scan at a resolution of 16 microns (.00062").

- Very high accuracy—as high as 10 microns (.00039")—large scanning area—as much as 48 inches in a single scan.
- Multiple lenses are utilised in a versatile system to scan small to big parts, and handheld devices are particularly portable for application..
- They are eye safe for 3D scanning of humans and animals.

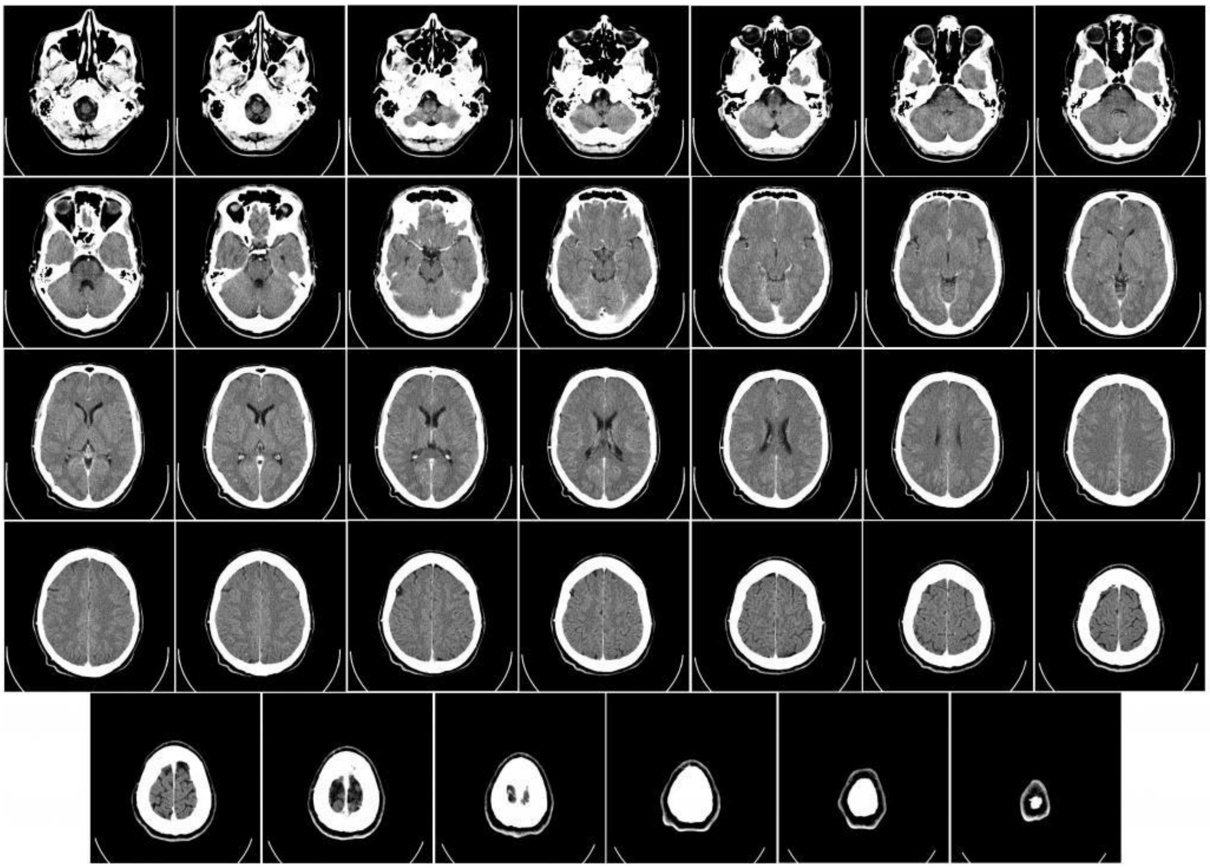
VOLUMETRIC TECHNIQUES-

A large number of two-dimensional X-ray pictures are combined in the medical imaging technique known as computed tomography (CT) to provide a three-dimensional view of an object's interior. Another imaging technique is magnetic resonance imaging (MRI), which offers far more contrast between the body's various soft tissues than computed tomography (CT) and is enormously beneficial in neurological (brain), musculoskeletal, and cardiovascular problems.

These methods produce a discrete three dimensional representation utilising isosurface extraction techniques that may be easily visualised, manipulated, or converted into a standard 3D surface..

COMPUTERIZED TOMOGRAPHY (CT SCAN):

A common medical procedure, CT scans are typically used to scan images of the interiors of living things. A CT scan involves scanning a portion and using X-rays to create a sequence of 2D pictures of distinct areas. Later, the 2D photos are superimposed to simulate a 3D model.



MODULATED LIGHT:

3D scanners that use modulated light cast a constantly shifting light onto the object. Typically, the light source just sinusoidally cycles its amplitude. The amount the pattern shifts in a camera-detected reflection indicates the light's journey distance.

There is no interference since modulated light also enables the scanner to reject light from sources other than a laser.

INDUSTRIAL:

Industrial computed tomography, MRI and microtomography are also utilised in various sectors to obtain a digital depiction of an object and its innards. These applications include analysing biological and paleontological specimens, reverse engineering, and non-destructive materials testing.

PASSIVE NON-CONTACT

Solutions for passive 3D imaging focus on detecting reflected ambient radiation rather than emitting any form of radiation themselves. Due to the fact that visible light is a commonly present ambient radiation, most solutions of this type can detect it.

Because they often only require basic digital cameras and not specialised technology, passive approaches can be relatively inexpensive.

In stereoscopic systems, the same scene is often captured by two video cameras placed significantly apart. The distance at each location in the photos can be calculated by examining the tiny variations in the photographs captured by each camera. The same principles that underlie human stereoscopic vision are used in this technique.

A single camera is often used by photometric systems, but several photos are taken in various lighting conditions. These methods make an effort to restore the surface orientation at each pixel by inverting the picture creation model.

Using a series of photos taken around a three-dimensional item against a sharply contrasted background, silhouette techniques utilise outlines.

PASSIVE PHOTOGRAMMETRIC NON-CONTACT METHODS

Based on the analysis of photographic images, photogrammetry gives accurate information on the three-dimensional shapes of real world objects.

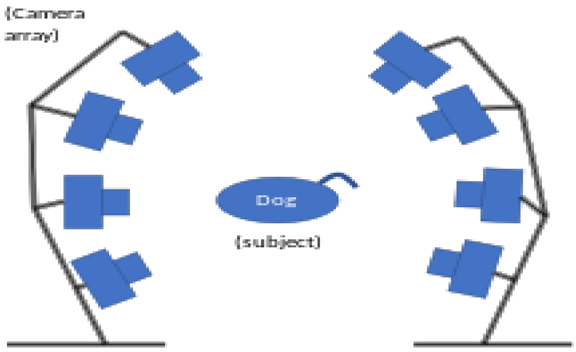
A 3D mesh, 3D point cloud, or 3D point is often delivered as the final 3D data.

Modern photogrammetry software applications analyse a large number of digital images automatically for 3D reconstruction; however, if the software is unable to automatically detect the three dimensional positions of the camera in the images, which will be a crucial step in the reconstruction pipeline, manual interaction may be necessary.

Software programmes such as PhotoModeler, RealityCapture, Geodetic Systems, Autodesk ReCap, and Agisoft Metashape are among those that are offered.

In order to take pictures of things for 3D reconstruction, close range photogrammetry often employs a handheld camera system, such as a DSLR which has a fixed focal length lens. Smaller things like a building facade, cars, sculptures, rocks, and shoes are examples of subjects.

Using a camera with wide angle lens, such as a 360 camera, wide angle photogrammetry used to capture building interiors or enclosed places.



A topic can be photographed from several angles, for as using a fixed camera array, and then reconstructed using photogrammetry to create a 3D mesh or point cloud.

Stereo visioning is a less expensive but generally worse 3D capturing technique.

Beyond a camera, no further hardware, such as lasers or projectors, is required. By using images of an object from two different camera angles, stereo vision simulates the stereo vision of the human eye.

Images of the same scene are taken during this process from two distinct perspectives. After that, any lens distortion is removed from the photos so that any straight lines in the scene appear straight in the final product. The image is then subjected to a filter that looks for object edges.

The two image sets are then matched for pixels to create 3D depth. While the surfaces in a scene aren't high contrast enough, or are too similar to one another, issues can arise when trying to match points between the photos, which depends on texture variation to discover edges and distinguishing features.

The standard stereo vision routine is strengthened by the addition of photogrammetry by increasing the number of camera sites.

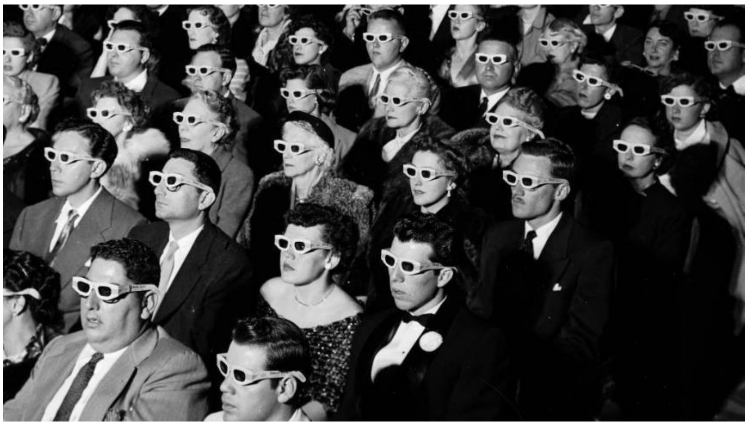
Photogrammetry frequently uses a huge camera system with numerous cameras.

Since a camera rig can be calibrated properly and kept that way for a long time, the setup's point matching requirements can be met with high consistency.

It is also feasible to use photogrammetry on video frames, selecting particular frames to represent the various camera positions.

This approach is less reliable and more prone to mistakes, but it is more accessible and adaptable to varied applications, as evidenced by its recent increase in usage in smartphone apps.

Robotics, 3D building mapping, and 3D movies all make use of stereo vision and photogrammetry techniques.



The technology is very straightforward. It entails fusing together images of a subject acquired from various perspectives.

With precise camera settings, the photographs are taken with a camera or even your smartphone, and then they are stitched together using specialised software. The software recognises pixels that represent the same physical point and combines images in accordance with that.

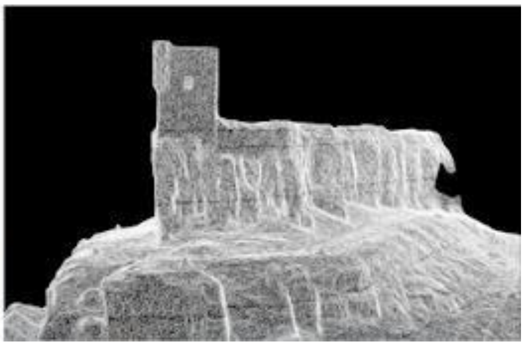
To generate an accurate model, the user must input data into the software such as the lens's distortion and focal length.

You can pick up your phone right now and begin capturing images using photogrammetry because it is that simple to use.

The precision of photogrammetry and how quickly it can gather data on an object are two of its main benefits.

Photogrammetric engineering Alternatively, it is called a 3D scan from photography. It uses particular computational geometrical procedures to reconstruct an object from 2D to 3D.

Large objects like stadiums and buildings can be scanned using photogrammetry since it is affordable and precise.

ACQUIRING DATA FROM LOCAL SENSORS:

The quickest, most automated approach to get height or distance data is by the use of terrestrial laser scanning equipment, such as Lidar.

Building height measuring with lidar or laser is proving to be quite successful. Building height extraction using commercial applications of airborne lidar and ground laser scanning technologies has shown to be a quick and precise process.

Determine building locations, building size, ground elevation, orientations, , rooftop heights, etc. using the building extraction job. The limits of the majority of structures may be represented by a collection of flat surfaces and straight lines since they can be described in sufficient depth in terms of general polyhedra.

Data is further processed before being stored in GIS databases, for as by representing building footprints as polygons.

Fruh and Zakhor offer a method to automatically construct textured 3D city models using laser scans and photos acquired from above and below as well as from a bird's-eye perspective. This method entails registering and fusing a complementing airborne model with the intricate facade models.

The project then uses texture processing to create virtual reality city models, such as by mapping terrestrial photos. The experiment proved that it is possible to quickly acquire 3D urban GIS. Another crucial information source for 3D building reconstruction is ground plans.

These ground plans turned out to be more trustworthy than the outcomes of automated processes because they include compiled data that has been clarified by human interpretation. Because of this, ground designs can significantly cut the cost of a reconstruction project.

Turntable Scanners-

Often structured light or laser based systems, these are used to capture the external shape of parts. They are particularly useful for parts of a smaller size (<300mm) with simple geometries.

The turntable is used to capture scans at set angular intervals. If you need to collect data from different angles not accessible from your single axis of rotation then a PCMM (portable coordinate measurement machine) may be a quicker solution.

PCMM Scanners-

These are laser scanners which are integrated into a PCMM device.

They are arguably the most versatile laser scanner available as they allow scanning from all angles as well as still delivering high accuracy data (+/- 50 microns).

They also excel at scanning different material types in one pass which structured light scanners can find difficult.

Hand held scanners offer dynamic, fast measurements of a scene or object. Often portable, they work just as well in a laboratory setting as they do out in the field.

See how we used hand held scanners in a wind tunnel to aid the University of Southampton in their Project Icarus student project.

Terrestrial Scanners

Mounted on a tripod these scanners are used for survey applications. Used in conjunction with targets or a total station they can quickly capture a scene.

Ideal for capturing everything from vehicles to buildings.

Mobile Scanners

Mobile scanners can be fitted to cars, ATVs, boats and trains. They are able to capture high quality, survey grade data while moving.

These are great for capturing long sections of road, complexes, entire sites and more.

All different types of scanner can produce a point cloud. Because of this their data sets can be combined in post processing. If you have a survey of a building using a terrestrial scanner, one could combine this data with a scan of a chair captured with a PCMM. This allows you to model the chair to a high level of detail and then position it accurately in the overall building model.

The 3D laser scanner is the most widely used type of scanner for home use.

To build a point cloud of an object's surface using laser scanning, two types of information are combined: data from a laser shining on the object and data from another sensor (typically a moving camera, or two stationary ones).

The known distance between the location of the camera and the laser source is used by 3D scanning software to stitch these data sets together and produce a model's points.

Finding the location of the laser line in the photos the camera took while scanning is necessary to create 3D geometry from a laser scan. The brightest pixel in a picture is typically a laser line, but other light sources may occasionally be visible.

By turning the laser on and off repeatedly, a stationary scanner can distinguish the laser line from all other lights by detecting the difference between them.

In a 3D scan, thousands of distinct points are recorded. A laser scanner, like a standard camera, can only record what is visible to it.

The collected points provide a precise depiction of the scanned object by capturing every aspect of its surface, including its colour, texture, and detail. Until the points in a collected point cloud are meshed into surfaces, it cannot be considered a waterproof digital object.

To link the points together into surfaces, the meshing process determines how they relate to one another. The consumer-grade Matter and Form 3D desktop scanner is an illustration of this.

USING PHOTOGRAPHS-

Using stereo picture pairings, 3D data capture and object reconstruction from images can be done.

The main method for 3D mapping and object reconstruction from 2D photos is stereo photogrammetry, or photogrammetry which is based on a block of overlapped images.

As with aerial photogrammetry, close-range photogrammetry has developed to the point where it is possible to use cameras or digital cameras to take close-up pictures of various objects, such as buildings, and then rebuild those photos.

Sisi Zlatanova has presented a semi-automatic technique for extracting 3D topologically organised data from 2D aerial stereo photos.

An orthogonal approach is then used to simplify the extracted building outlines in order to improve the cartographic quality. It is possible to determine the ridgelines of building roofs using watershed analysis. The buildings are divided into categories based on ridgelines and slope data.

In a 3D scan, thousands of distinct points are recorded. A laser scanner, like a standard camera, can only record what is visible to it.

The collected points provide a precise depiction of the scanned object by capturing every aspect of its surface, including its colour, texture, and detail. Not a captured point cloud.

MATERIAL AND METHODS

SOURCE OF DATA

Patients admitted with visible body swellings at **SHRI B.M. PATIL MEDICAL COLLEGE, VIJAYAPURA between October 2020 to November 2022**

STUDY PERIOD

OCTOBER 2020 to NOVEMBER 2022

METHODS OF DATA COLLECTION

It is a prospective study done on patients who have visible swelling, tumors over body in Department of Surgery, BLDE (DEEMED TO BE UNIVERSITY) SHRI B.M. PATILMEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE, VIJAYAPURA–586103, KARNATAKA.

- After taking consent the selected patients will undergo

- Preoperative 3D scanning and counselling: The patient is made to stand with exposed area of swelling, Infrared depth sensors and hand-held **mobile device** (Samsung note10 plus) with scanner application installed had to be moved in a pattern from left to right until all aspects of the swelling of patient's body have been covered by sensors. Scanned images are used for counselling about the disease and the operative procedure. The distance between the camera and the scanning device should be 30 to 50 cm.

- Intraoperative excised specimen is scanned, and the images are shared with the pathologist.
- Post-operative regional scanning is done.
- The patient 3D scanned data & information is documented.

- Detailed history will be taken, and patients will be examined thoroughly.
- Patients will undergo necessary investigations: Hemoglobin, Total count, Differential count, Erythrocyte sedimentation rate, Platelet count, Bleeding time, Clotting time and Biochemical routine including Blood Urea, Serum creatinine and urine analysis.
- Any other investigations will be done if required based on history and other complaints.
- Written informed consent will be obtained from all the patient.
- Patient is explained about the procedure of 3D scanning, and operative procedure in detail.

STUDY DESIGN

A prospective OBSERVATIONAL study.

RESEARCH HYPOTHESIS

3D surfacing imaging offers an objective, non-invasive, radiation-free diagnostic tool for the pre, intra and postoperative documentation of the human body swelling which is cost effective, easy to operate in minimal time and plays a role in communication, annotations of specimen for HPR.

SAMPLE SIZE

With anticipated Mean±SD assessment with Mobile 3D system 28.7±3.1 sec[8], the study would require a sample size of 61 patients with 95% level of confidence and a precision of 0.8

Formula used

- $$n=\frac{z^2\ p*q}{d^2}$$

Where Z= Z statistic at α level of significance

d^2= Absolute error

P= Proportion rate

q= 100-p

- **Statistical Analysis**
- The data obtained will be entered in a Microsoft Excel sheet, and statistical analysis will be performed using statistical package for the social sciences (Version 20).
- Results will be presented as Mean (Median) ±SD, counts and percentages and diagrams.
- For normally distributed continuous variables will be compared using Independent t test. For not normally distributed variables Mann Whitney U test will be used.

- The results of pre and post documentation will be compared by Paired t test/ Wilcoxon signed rank test.
- Categorical variables will be compared using Chi square test.
- Correlation between variables will be calculated by Person's/ Spearman's Correlation.
- p<0.05 will be considered statistically significant. All statistical tests will perform two tailed.

INCLUSION CRITERIA

- Patients with visible swellings over the body.

EXCLUSION CRITERIA

- Pregnancy
- Patients not fit for anesthesia
- Diabetic foot

The present study was carried out at the Department of General Surgery, **B.L.D.E (Deemed to be University) SHRI B.M PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA**

STUDY DESIGN: Single Centre, prospective observational study

TOTAL SUBJECTS: A total of 100 patients were enrolled in the study.

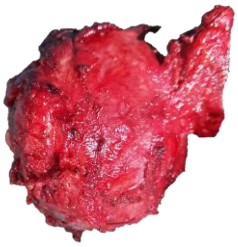
3D IMAGES

CASE 1 HUGE LIPOMA OVER NAPE OF NECK

PREOPERATIVE 3D SCAN

INTRAOPERATIVE SPECIMEN SCAN

POSTOPERATIVE REGIONAL SCAN



CASE 4 : RIGHT CHEST SWELLING

PREOPERATIVE 3DSCAN

INTRAOPERATIVE SPECIMEN SCAN

POSTOPERATIVE REGIONAL SCAN

CASE 2: MULTINODULAR GOITRE

PREOPERATIVE 3DSCAN

INTRAOPERATIVE SPECIMEN SCAN

POSTOPERATIVE REGIONAL SCAN

CASE 3 : LEFT CARCINOMA BREAST

PREOPERATIVE 3DSCAN

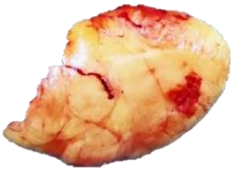
INTRAOPERATIVE SPECIMEN SCAN

POSTOPERATIVE REGIONAL SCAN

4

CASE 5 : RIGHT INFRAAXILLARY LIPOMA

PREOPERATIVE 3DSCAN



INTRAOPERATIVE SPECIMEN SCAN

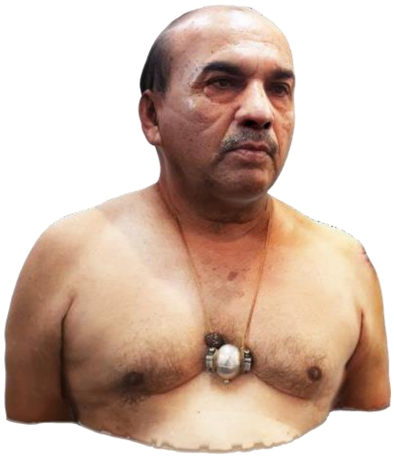
POSTOPERATIVE REGIONAL SCAN

CASE 5 :LEFT SUBSCAPULAR LIPOMA

PREOPERATIVE 3DSCAN

INTRAOPERATIVE SPECIMEN SCAN

POSTOPERATIVE REGIONAL SCAN



CASE 5 : LEFT SHOULDER NAEVUS

PREOPERATIVE 3DSCAN

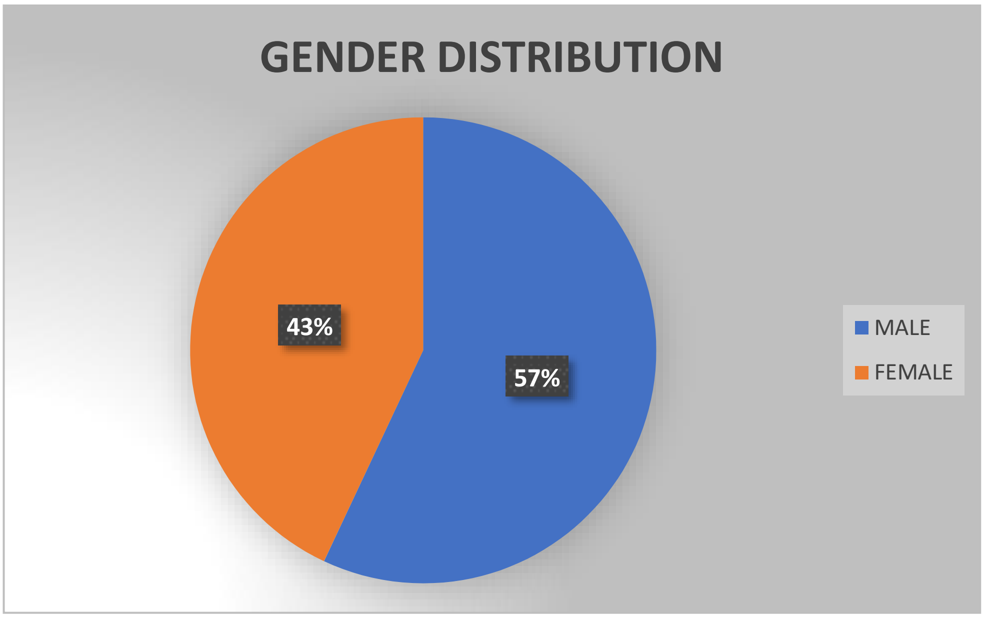
INTRAOPERATIVE SPECIMEN SCAN

POSTOPERATIVE REGIONAL SCAN

RESULTS

TABLE 1. DISTRIBUTION OF CASES ACCORDING TO GENDER

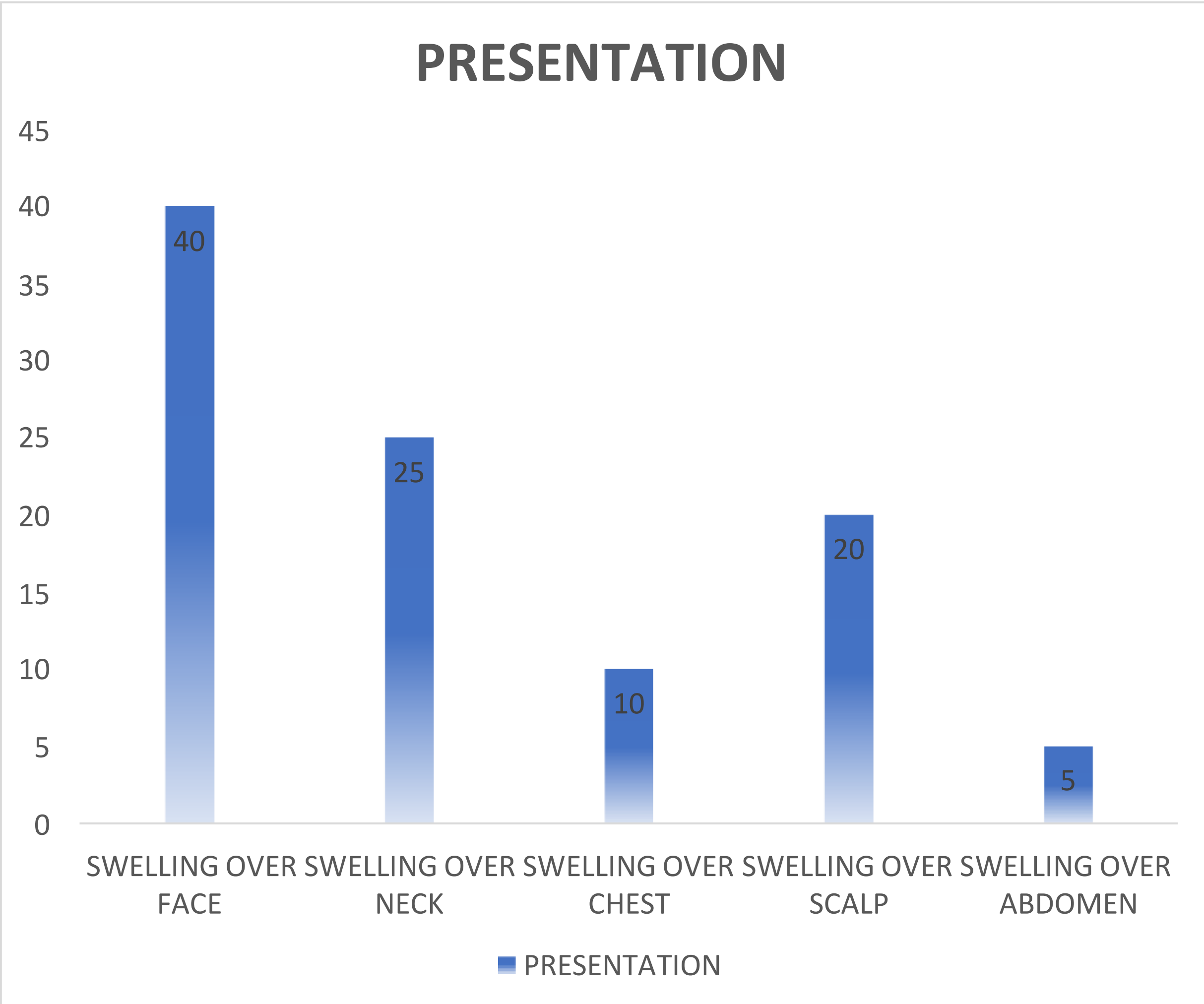
GENDER	NUMBER OF CASES	PERCENTAGE (%)
MALE	**57**	**57%**
FEMALE	**43**	**43%**
TOTAL	**100**	**100%**



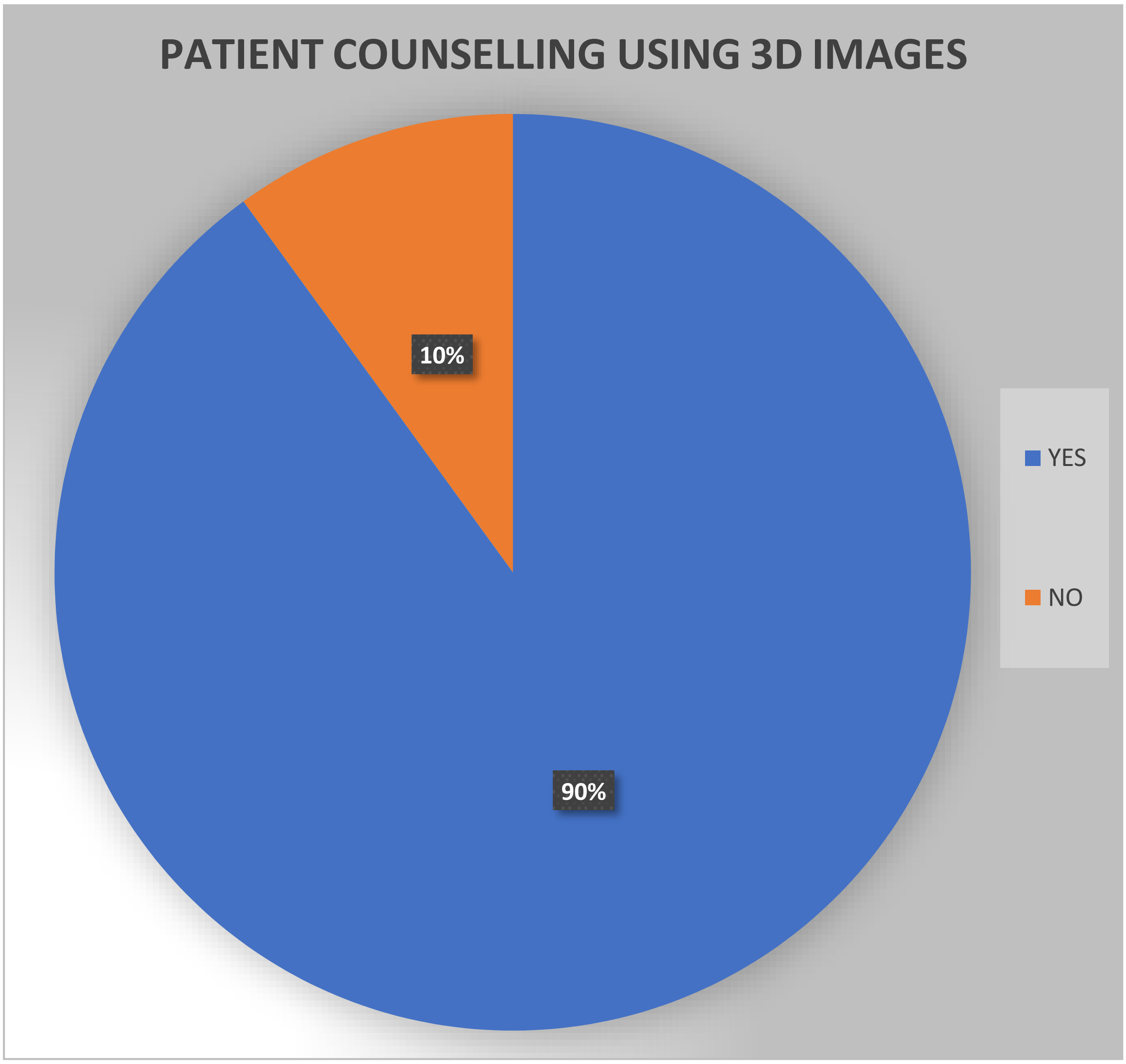
PIE CHART SHOWS GENDER DISTRIBUTION

- Out of 100 patients, 57 patients were male and 43 patients were female.

FIG 1 SHOWS PATIENT'S PRESENTATION

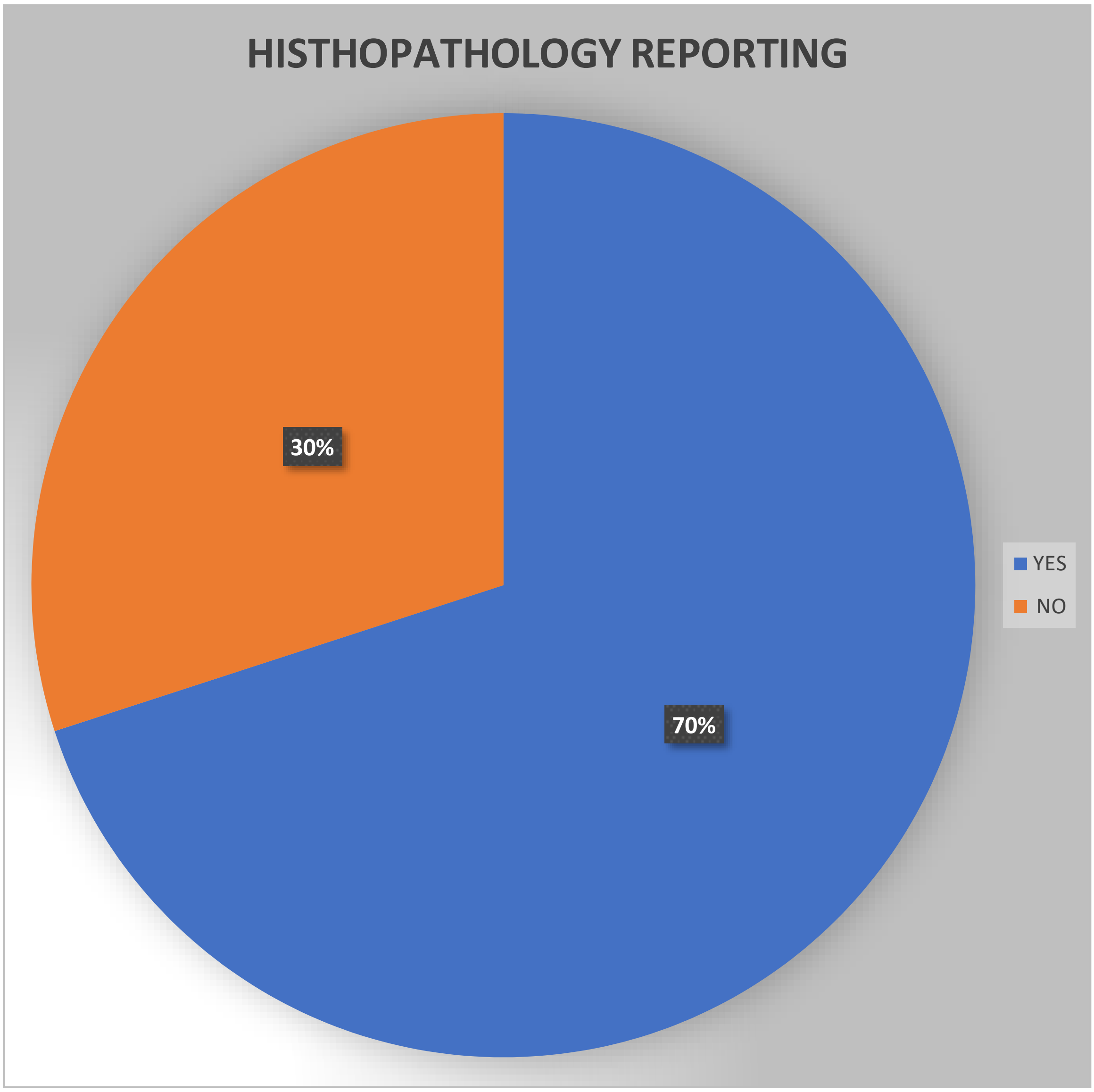


- Out of 100 patients, 40 patients presented with swelling over face, 24 patients with swelling over neck, 20 patients with swelling over scalp, 10 patients with swelling over chest and 5 patients with swelling over abdomen.



PIE CHART SHOWING UTILIZATION OF 3D IMAGING TECHNIQUE FOR PATIENT COUNSELLING

- **OUT OF 100 PATIENTS, 90 PATIENTS SUCCESSFULLY COUNSELLED AND PROVIDED EDUCATION USING 3D IMAGES.**



PIE CHART SHOWING UTILIZATION OF 3D IMAGES IN ANNOTATIONS OF HISTOPATHOLOGICAL REPORTING .

- **70% OF 3D IMAGES HELPED PATHOLOGIST IN ANNOTATIONS OF HISTOPATHOLOGICAL REPORTING.**

TABLE SHOWING LEAD TIME (START TO END TIME OF SCAN)

	MEAN AVERAGE TIME TAKEN
PREOPERATIVE SCAN	**35.5 SECONDS**
INTRAOPERATIVE 3D SPECIMEN SCAN	**58.5 SECONDS**
POST-OPERATIVE REGIONAL SCAN	**40.5 SECONDS**
TOTAL	**134.5 SECONDS**

- **AVERAGE TIME TAKEN FOR PREOPERATIVE SCAN IS 35.5 SECONDS, INTRAOPERATIVE SPECIMEN SCAN IS 58.5 SECONDS AND FOR POST-OPERATIVE REGIONAL SCAN IS 40.5 SECONDS.**

DOCUMENTATION AND DATA GENERATION:

- **ALL THE 100 PATIENTS WHO WERE ENROLLED IN OUR STUDY ARE DOCUMENTED IN OUR HOSPITAL MANAGEMENT SYSTEM (HIMS) SOFTWARE AND THEY ARE UTILIZED FOR FOLLOW-UP OF PATIENTS, ANY RECURRENCES AND FOR FURTHER STUDIES.**
- **ALL THE DATA FROM MOBILE IS EXTRACTED AND COPIED TO DESKTOP WHICH IS THEN TRANSFERRED AND SAVED IN OUR HOSPITAL MANAGEMENT SYSTEM SOFTWARE**.

- **3D VISUALIZATION:**
  - 3D images provided pre-visualization such as patient-clinician interaction in surgical planning.
  - Created visual representation of the body for clinical analysis which helped the diagnostic confidence of the patients and easy to read the solution.
  - 3D visualization helped in planning of surgery (eg. shape of incision, need of flaps etc.) and provided education to the patients.
  - It helped surgeon to know the anatomy of 3D image and allowed solving the issue.
  - 3D images helped to detect any deformities through the analysis of patients body shape **(Fig 1)**

Fig 1. Shows 18 year old male with Angiosarcoma of face.

HIGH ACCURACY 3D IMAGES:

- We were able to capture highly accurate 3D images which provided with a more holistic view and helped to achieve an optimal treatment compared to conventional 2D realm of radiography.
- This procedure is fast and taken within seconds and is highly preferred instead of measurement.
- It automatically extracts 360 degree measurements from scans while eliminating manual measurement and transcription errors.
- Even smallest scars, pimples and skin creases can be seen on 3d images **(Fig 2 and 3)**

Fig2. Shows 55 year old female patient with Thyroidectomy scar.

Fig 3. Shows 74 year old male with Basal cell carcinoma left nasolabial fold

➢ RECONSTRUCTIVE SURGERY:

- 3D scanner generates a virtual 3d model in few seconds which is viewable on a computer system.
- 3D models have colors and texture as the original. it detects things which human eye cannot do it.
- 3D scanner automatically extracts measurements for the state of disease, healthy shape, size of the body.
- Around the person, it makes a full circle capture body shape and size from all angles and gives precise measurements **(fig4).**


Fig 4a. Showing case of carcinoma left breast. Fig 4b showing after 1 month of left modified radical mastectomy.

now patient requires reconstructive surgery, so this documented 3D images helps in further plannig of proposed surgery.

- **DOCUMENTATION AND FOLLOW-UP:**

- 3D images generated in mobile are transferred to our hospital software and stored in individual patient databases which are beneficial in follow-up cases.
- Helped in follow up cases of tuberculosis lymphadenitis, cold abscess, generalised lymphadenopathy patients. **(fig 5 and 6).**

Fig 5. Shows 34 year old female case of Cold abscess.

Patient was followed for any recurrence and for further management and evaluation.

Fig 6. Shows 58 year old male case of Right cervical lymphadenopathy.

DISCUSSION:

3D scanning is accurate, versatile, and operates at a cheap cost. 3D scanning is safe to employ on the human body because it doesn't damage the skin. It provides a speedy resolution and quantifiable process improvement. It offers very reliable processes and repeatable, accurate measurement. Our study also shows 3D scanners offers a reliable evaluation of form, texture, true colors, symmetry, high speed and extreme accuracy.

The time is right for a revolution in 3D scanning technology, one that makes use of scanners in routine clinical procedures much as how MRI, x-ray, and CT scanning revolutionised internal body imaging.

After being gathered in just a few seconds, a single scan can rapidly analyse the patient's measurements in three dimensions. The rapid scanning technique prevents the subject from moving.

The 3D scanner scans the patient's body without coming into contact with it to ensure that there are no outside influences on the measurement. The best 3D solution now available, it is quick, easy, and safe to use, and it poses no health hazards to patients.

3D scanning is a supplementary technique that works well with 3D printing. Since it monitors the body more rapidly and correctly from the outside, it is crucial for the medical industry. In the medical sector, 3D scanners have become a potentially beneficial scanning tool.

Researchers and technologists can holistically integrate research with clinical and surgical procedures by utilising 3D scanning technology to improve present medical applications. Patients may be provided a deeper knowledge of their pathology with increased team communication and preoperative planning/diagnosis using models scanned by this technique.

The application of 3D scanning to the medical sciences is quite advantageous. From the designing stage through the actual implementation stage (part), the model is very helpful for the patient and the doctors. 3D scanners may create reliable results for the usage of a variety of medical specialists. For daily use, it just needs fundamental instruction and is easy to use. Negative castings or impressions of the patient's body measurements are frequently taken. These real moulds must be transported from the clinic to the lab. Thanks to 3D scanning, the entire operation is carried out electronically, enabling the transmission of patient measures to the internet and other locations.

The physical object is converted into a digital 3D file, which gives information for manufacturing and analysis right away. Each patient can receive a personalised medical solution thanks to the 3D scanner.

This technology carries zero hazards and is fully safe for the patient and the surgical team. Excellent method for capturing an object in both colour and black and white.

• 200 patients participated in a study by Chromy and Zalud Lerch et al. on "3D scanner as an alternative to established modalities of medical imaging." concluded that the 3D model offers clinicians a more comprehensive perspective, precision, and assistance in achieving an ideal therapy when compared to the traditional 2D photographs.

• A study by Daanen H. et al. in 2008 on 120 participants titled "Made to measure pattern development based on 3D whole body scans" came to the conclusion that 3D previsualization allows surgeons to see a 3D depiction of the patient's anatomy and aids in surgical planning and patient education.

• A 2018 study by Javaid M., Haleem, et al. titled "Current Status and Challenges of Additive Manufacturing in Orthopaedics" found that 3D scanning is affordable, quick, and effective in everyday use.

• A study on "Customized pressure garment development by employing 3D scanned body image" was undertaken in 2011 by Salleh MNB, Acar M, et al. Conclusion: 3D scanners offer versatility for scanning diverse shapes and sizes of a product and are capable of scanning the complete body as well as its minute features.

• In the study "3D Scanning System for In-Vivo Imaging of Human Body" by Miguel Ares et al. The study of aesthetic applications has led to the development of a 3D scanner measuring broad regions of the human body, including 3D information of the human body with overlay colour texture data, and the system contains repositioning tools for user-friendliness.

CONCLUSION

3D imaging offers an objective, non-invasive, radiation-free diagnostic tool for the pre, intra and postoperative documentation of the human body swelling which is cost effective, easy to operate in minimal time and plays a major role in communication, annotations of surgery and specimen for patients, surgeons and pathologist.

Our study showed high potential of 3D imaging which offered a reliable evaluation of true colors, texture, high accuracy, form, symmetry which helped patients in counselling and provided education.

Our study concludes the hallmark of 3D scan which is minimal lead time (start to end time of scan) which is quicker in design, creation and iteration.

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ANNEXURE

1. ETHICAL CLEARANCE

B.L.D.E. (DEEMED TO BE UNIVERSITY) IEC/NO-09/2021 Date-22/01/2021

(Declared vide notification No. F.9-37/2007-U.3 (A) Dated. 29-2-2008 of the MHRD, Government of India under Section 3 of the UGC Act, 1956)

The Constituent College

SHRI. B. M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Institutional ethical committee of this college met on 11-01-2021 at 11-00 am to scrutinize the synopsis of Postgraduate students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected and revised version synopsis of the Thesis has been accorded Ethical Clearance

Title: Role of 3D scanning in visible surgical swellings.

Name of PG student: Dr Dr Malim Abdul Arshad, Department of Surgery

Name of Guide/Co-investigator: Dr Deepak Chavan, Professor
Department of Surgery

DR .S.V.PATIL
CHAIRMAN, IEC

Institutional Ethical Committee
B L D E (Deemed to be University)
Shri B.M. Patil Medical College,
VIJAYAPUR-586103 (Karnataka)

Following documents were placed before Ethical Committee for Scrutinization:

1. Copy of Synopsis / Research project
2. Copy of informed consent form
3. Any other relevant documents.

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2. PARTICIPANT CONSENT FORM

Participant' s name: **Address:**

TITLE OF THE PROJECT: : "ROLE OF 3D SCANNING IN VISIBLE SURGICAL SWELLINGS"

The details of the study have been provided to me in writing and explained to me in my own language. I confirm that I have understood the above study and had the opportunity to ask questions. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without the medical care that will normally be provided by the hospital being affected. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s). I have been given an information sheet giving details of the study. I fully consent to participate in the above study.

____________________ ______________________

(Participant) (Date)

____________________________ ______________________

(Witness to signature) (Date)

____________________________ ______________________

(Investigator to signature) (Date)

3. PATIENT INFORMATION SHEET

TITLE OF THE PROJECT:

"ROLE OF 3D SCANNING IN VISIBLE SURGICAL SWELLINGS"

NAME OF THE INVESTIGATOR: DR. MALIM ABDUL ARSHAD

NAME OF THE GUIDE: DR. DEEPAK R CHAVAN

PROCEDURE:

CONFIDENTIALITY OF RECORDS:

This study will become a part of hospital records and will be subject to the confidentiality. If the data are used for publication, no name will be used. And photographs will be used with special written permission.

INJURY STATEMENT:

In the unlikely event of injury resulting directly from participation in this study, the injury will be reported promptly and the appropriate treatment will be given.

REFUSAL OR WITHDRAWAL OF PARTICIPATION:

Participation is voluntary and you may refuse to participate or withdraw consent and discontinue participation in the study at any time.

I, **DR. MALIM ABDUL ARSHAD** (Investigator) have explained to the patient in detail about the study in their own language and the written copy of the same will be given to participant.

INVESTIGATOR' S NAME AND ADDRESS:

DR. MALIM ABDUL ARSHAD

POST GRADUATE

DEPARTMENT OF SURGERY

SHRI B M PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE,

B.L.D.E.(DU)

VIJAYAPURA-586103

ANNEXURE IV

1. PROFORMA FOR TAKING CASE

Date:

Name:

Age:

Sex:

IP NO:

Occupation:

Address:

Mobile No.:

Chief complaints:

Brief history:

Past history:

Personal history:

General physical examination:

Vitals

Local examination:

Inspection:

Palpation:

Systemic examination:

Per abdomen:

Cardiovascular system:

Respiratory system:

Central nervous system:

Provisional diagnosis:

Management:

Investigations:

1. HEMOGRAM- HB, TC, DC, PLATELET COUNT, RANDOM BLOOD SUGAR,BLOOD UREA, SERUM CREATININE, HIV, HBSAG, HCV, BLEEDING TIME, CLOTTING TIME, ELECTROCARDIOGRAM, CHEST X-RAY PA VIEW

Final diagnosis:

Treatment:

PREOPERATIVE SCAN:

INTRAOPERATIVE SPECIMEN SCAN:

POSTOPERATIVE REGIONAL SCAN:

Outcomes / followup-

MASTER CHART

S.NO	NAME	AGE	SEX	IP NO	DIAGNOSIS
1	RAYAPPA	80	M	292808	HUGE LIPOMA OVER NAPE OF NECK
2	RAJPUT	50	M	333038	RIGHT PAROTID ABSCESS
3	SIDRAM	76	M	313473	RIGHT LOWER LIMB VARICOSE VEINS
4	SURESH	47	M	332274	PAPILLOMA OVER STERNUM
5	BHEEMSHANKAR	46	M	106902	LIPOMA OVER NAPE OF NECK
6	ROOBI	40	F	322050	GRANULOMA OVER LEFT CHEEK
7	BASAMMA	46	F	304743	FOLLICULAR CA THYROID WITH METS
8	MAHANANDA	36	F	288231	SOLITARY THYROID NODULE
9	MAHADEVI	53	F	310028	TOXIC NODULE
10	PANDIT	25	M	304028	DERMOID OVER GLABELLA
11	HANAMANTH	70	M	340898	SEBACEOUS CYST OVER FRONTAL REGION
12	ABDUL WAHID	44	M	22460	SEBACEOUS CYST OVER NAPE NECK
13	PARSHURAM	40	M	106934	LIPOMA OVER NAPE OF NECK
14	HUCCHAVA	32	F	179895	LEFT CA BREAST
15	ARJUN	12	M	274055	SCHWANOMMA LEFT SIDE OF NECK
16	SHARADA	55	M	238471	HYPERTHYROIDISM
17	SHARANI	33	F	267891	SEBACEOUS CYST OVER SCALP
18	PARSHURAM	35	M	240345	SEBACEOUS CYST LEFT PARIETAL REGION
19	MAHANANDA	33	F	267891	MULTIPLE SEBACEOUS OVER SCALP
20	SANGEETHA	20	F	152891	RIGHT EAR KELOID
21	ALIYA	8	F	139702	RIGHT AXILLARY HEMANGIOMA
22	ASHABAI	38	F	153790	LEFT SOLITARY NODULE THYROID
23	AKKUBAI	60	F	195539	DERMOID OVER RT FOREHEAD WITH CATARACT
24	NAGAPPA	70	M	168293	LEFT CA BREAST
25	NAGENDRA	45	M	187654	TB LYMPH NODE
26	ABHISHEK	15	M	190310	RT GYENOCOMASTIA
27	NEELAMMA	46	F	186578	LIPOMA OVER LOWER BACK
28	NAGAMMA	82	F	181677	ACUTE GE WITH HYPERTHYROIDISM
29	GOWRAMMA	43	F	225167	RIGHT FACE CELLULITIS
30	JANAKI	35	F	402750	LEFT PAROTID ABSCESS
31	GANGABAI	40	F	156266	SEBACEOUS CYST OVER SCALP
32	PRAVEEN	29	M	298301	R SOLITARY THYROID NODULE
33	RUKMINI	30	F	129295	RIGHT SHOULDER DERMOID
34	LAXMAN	46	M	117768	LEFT SHOULDER NAEVUS
35	MANJULA	37	F	211027	LIPOMA LEFT SUPRACLAVICULAR
36	BASVARAJ	60	M	320036	LEFT BACK SEBACEOUS CYST
37	SHANKARAPPA	60	M	109606	CA THYROID
38	SANGAPPA	40	M	140777	LIPOMA RIGHT BACK SHOULDER
39	SHIVUM	59	M	24355	CRANIOPLASTY
40	MALAMMA	45	F	124768	SEBACEOUS CYST OVER LOWER BACK

41	VITTAL	33	M	95898	RIGHT GYNECOMASTIA
42	HUSENBI	55	F	182655	RIGHT FRONTAL DERMOID
43	BINGERI	60	M	156744	R CERVICAL LYMPHADENOPATHY WITH ABSCESS
44	SHANKAREPPA	40	M	396179	R NEUROFIBROMATOSIS
45	HANAMANTH	60	M	356544	BASAL CELL CARCINOMA
46	DRUPADA	40	F	378576	MNG
47	GANAPATHI	39	M	367109	RANULA
48	SHANTABI	60	F	383958	R PAROTID ABSCESS
49	JAYESH	17	M	28765	ANGIOSARCOMA FACE
50	LAXMAN	45	M	117768	L SHOULDER NAEVUS
51	MANJULA	40	F	211961	L SUPRACLAVICULAR LIPOMA
52	PARVATI	54	F		RIGHT PLEOMORPHIC ADENOMA
53	RAJESH	30	M	278341	MULTINODULAR GOITRE
55	KALAVATI	55	F	245784	MULTINODULAR GOITRE
56	NAJAMA	40	F	289123	MNG
57	KAVITHA	17	F	149876	LEFT PAROTID ADENOMA
58	RUKMINI	43	F	129295	L SHOULDER LIPOMA
59	MOTIBAI	47	F	168654	SEBACEOUS CYST BACK
60	PRAKASH	45	M	107906	LIPOMA NAPE NECK
61	DHARMARAJ	38	M	189678	DERMOID OVER SCALP
62	YALAVVA	42	F	178432	LIPOMA OVER LOWER BACK
63	BERAMMA	40	F	187531	MNG
64	MALAVVA	78	F	118679	RIGHT EAR KELOID
65	NARSAPPA	57	M	118534	SOLITARY THYROID NODULE
66	SHIVANAND	68	M	216032	RIGHT COLLOID GOITRE
67	MUTAPPA	68	M	118954	LIPOMA OVER BACK
68	NARESH	16	M	127654	BILATERAL GYENACOMASTIA
69	KAMALABAI	46	F	223035	MNG
70	BASVARAJ	63	M	158041	RIGHT PAROTID ADENOMA
71	PULASING	52	M	333038	LEFT PAROTID ADENOMA
72	RAMZAN	35	F	205904	R SOLITARY THYROID NODULE
73	PULAYYA	73	M	208976	RIGHT ZYGOMA SCC
74	PRAKASH	46	M	204054	RIGHT LL VARICOSE VEINS
75	MAHADEVI	40	F	276890	MULTINODULAR GOITRE
76	RAMESH	55	M	246790	LEFT PAROTID SWELLING
77	NIMBAWWA	82	F	261253	RIGHT SHOULDER LIPOMA
78	GUNDAPPA	74	M	181679	RIGHT PAROTID MALIGNANCY
79	GANESH	48	M	176348	LIPOMA OVER OCCIPITAL REGION
80	KAVITHA	26	F	214532	LEFT PAROTID ABSCESS
81	SUSHMITHA	42	F	238907	GLABELLA CYST
82	HANAMANTH	47	M	259082	LIPOMA LEFT NAPE
83	LALABI	56	F	247560	RIGHT LL VARICOSE VEINS
84	SHILPA	41	F	113490	DERMOID OVER FRONTAL AREA
85	ASHWINI	54	F	143290	LEFT SHOULDER LIPOMA
86	ASHOK	38	M	125640	LIPOMA OVER POSTAURICULAR AREA
87	BHIMRAY	35	M	132790	RIGHT FOOT GRANULOMA

88	MALLIKARJUN	50	M	225487	LIPOMA OVER NAPE OF NECK
89	NARESH	30	M	223190	PEDUNCULATED LIPOMA OVER EPIGASTRIUM
90	BHIMANNA	56	M	227543	CARCINOMA LIP
91	SUNITHA	41	F	237980	LEFT COLLIOD NODULE
92	NAGAPPA	70	M	168293	CARCINOMA LEFT BREAST
93	PARVATI	28	F	122434	HYPERTHYROIDISM
94	MAHANANDA	33	F	267891	EPIDERMAL CYST SCALP
95	SALEEM	45	M	22460	SEBECEOUS CYST OVER NAPE NECK
96	RAMESH	50	M	388890	DERMOID CYST OVER LEFT EYEBROW
97	SHANTAPPA	43	M	143767	LEFT ADVANCED CA BUCCAL MUCOSA
98	NAGAMMA	40	F	334590	DERMOID CYST OVER SCALP
99	CHANDAWWA	32	F	362123	RIGHT NECK ABSCESS
100	SHARANAPPA	59	M	338939	LIPOMA OVER RIGHT SCAPULA
101	PULASING	49	M	307787	LEFT PAROTID ADENOMA
102	MALAPPA	45	M	367833	LIPOMA OVER LEFT SHOULDER
103	ANNAPURNA	39	F	395990	SOLITARY THYROID NODULE
104	LAXMIBAI	56	F	337543	LIPOMA OVER RIGHT AXILLA