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# 1. Brief Introduction

The Knee replacement Surgery Navigation System is developed by Zeugma, is an advanced robotic assisted surgical navigation system designed to improve the precision and accuracy of knee replacement surgeries. It integrates preoperative planning, intraoperative navigation, and robotic assistance to enhance patient outcomes.

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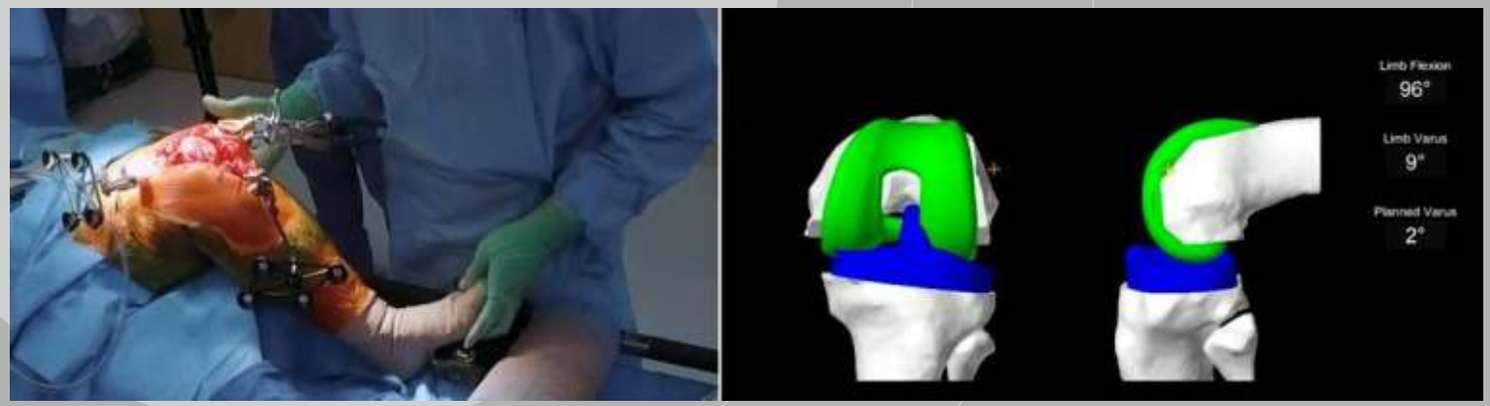
# 2. Advantages of Navigation System




**Real-Time Surgical Guidance**
Provides 3D visualization for precise implant alignment.

**Reduced Variability**
Standardizes procedures,minimizing surgeon_ dependent errors.

**Improved Accuracy**
Ensures millimeter level precision in bone cuts and implant positioning.

**Faster Recovery & Better Longevity**
Properly aligned implants lead to less wear and tear, extending implant life

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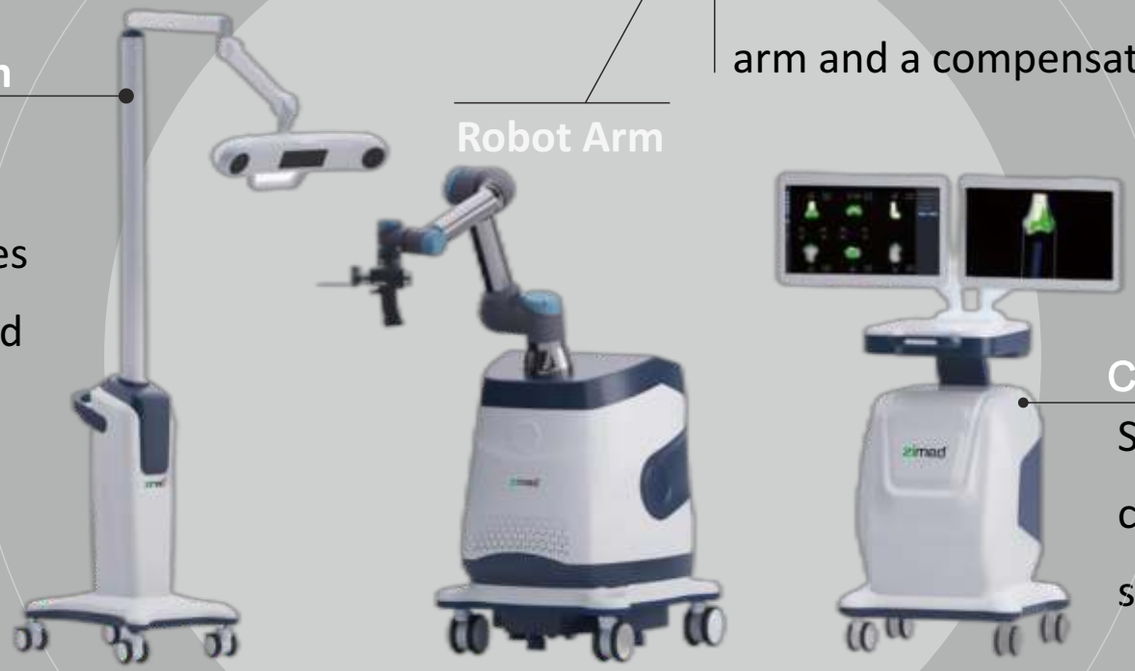
# 3.1 Component of Navigation System Main Hardware

**NIR Optical Tracking System**

The binocular camera captures the position of the patient and the robotic arm in real time with near-infrared light.



**Robot Arm**

Six degrees of freedom robotic arm, equipped with a force sensor that allows to manually move the robotic unit to the desired location by measurement of forces exerted at the end of the arm and a compensation principle.

**Control Center**

Software in the control center to assist doctors surgical navigation.

High Accuracy: 0.08mm RMS

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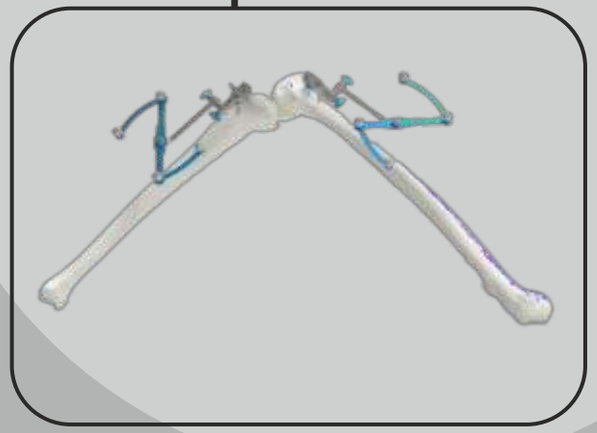
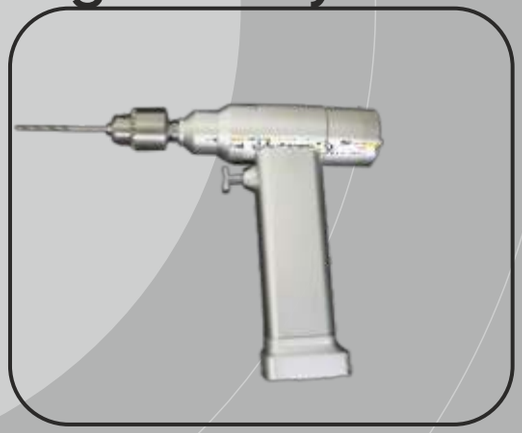
## Accessories

# 3.2 Components of Navigation System



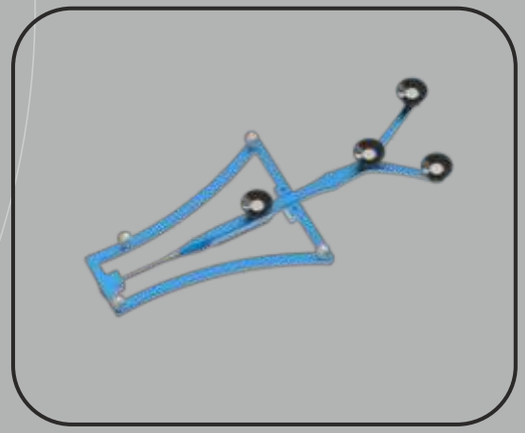
### Bone Reference Frame

Ensure sprecise alignmentand positioning of surgical instruments and implants relative to the patient'sanatomy.



### Electric Drill

For installing removing lag screws.



### Probe and Calibration tool

With markers attached is used to collect anatomical data, register landmarks, and verify alignment .

### Osteotomy Verification Plate

To verify the accuracy of the osteotomy surface and ensures the bone cuts are made precisely according to the preoperative plan, helping to achieve proper implant fit and alignment.

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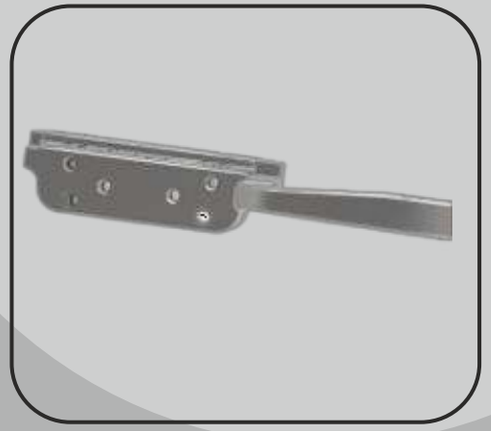
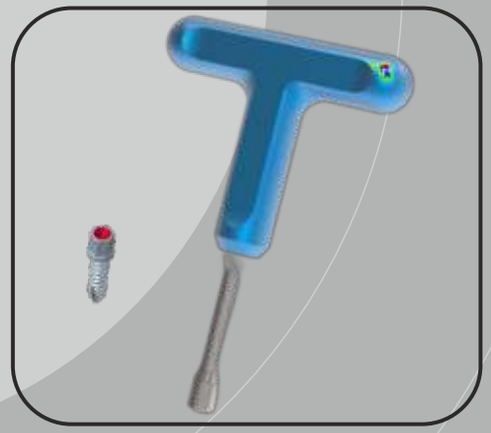
## Accessories

# 3.2 Components of Navigation System



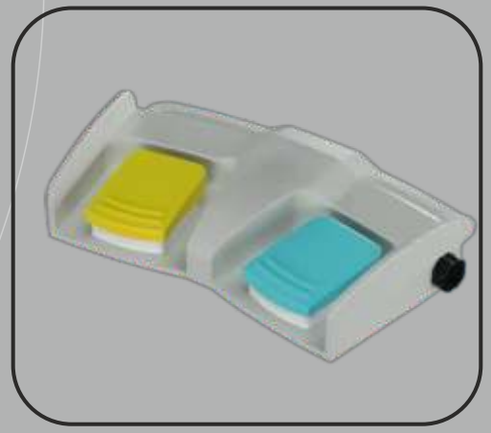
### GuidePlate

It serves as a fixed reference structure to guide bone resections and ensure optimal alignment of the knee implants.



### Wrenches

For installing/removing the Reference pins.



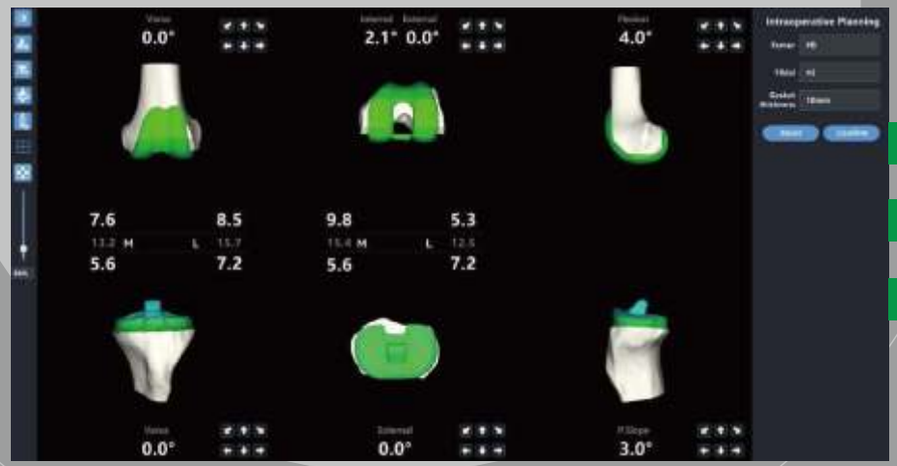
### FootPedal

It allows hands-free execution of specific commands without interrupting the surgical workflow.

### Disposable ProtectiveDrape

To verify the accuracy of the osteotomy surface and ensures that the bone cuts are made precisely according to the preoperative plan, helpingtoachieveproperimplantfit and alignment.

# 4.1 Software of Navigation System




**1. Software for Precise Pre - Operative Implant Planning**

- Personalized implant Sizing
- Precision implant positioning
- Limb alignment planning

**2. Software for intraoperative Planning**

- Allows for Optimal Ligament Balancing
- Allows Optimal Alignment and function

**3. Robotic Arm Assisted, Surgeon Controlled, Bone Preparation**

- Provides safe, Consistent, Precision Bone Cuts.
- Protects Soft Tissues, Nerves and Vessels from Injury

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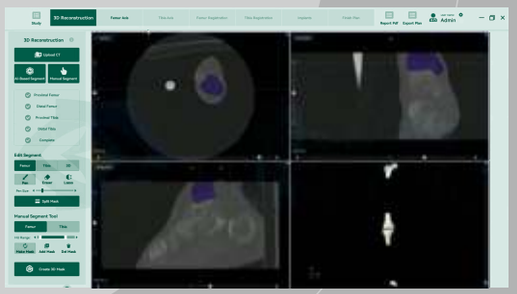
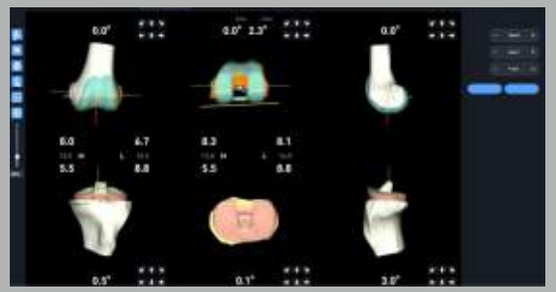
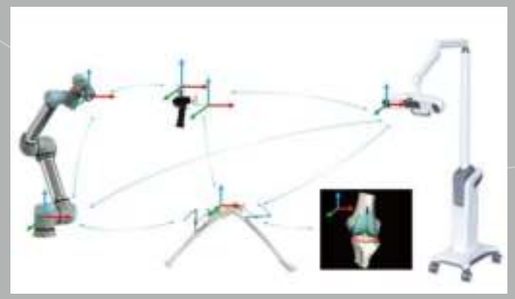
# 4.2 Software of Navigation System – flow

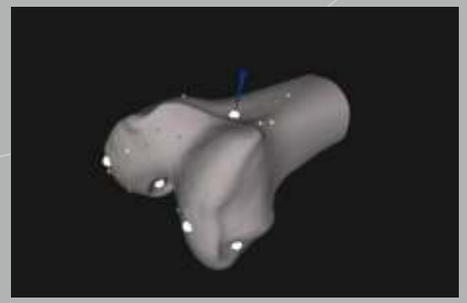
1. User/Patient Management → 2. Image processing → 3. Anatomical point / axis location → 4. Prosthesis planning →

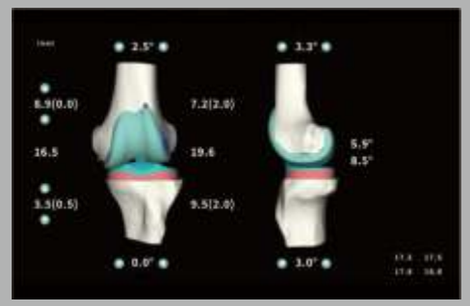


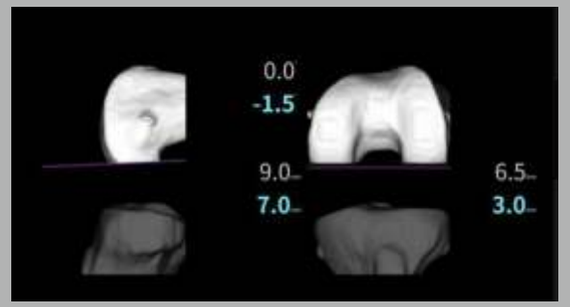


→ 5.System Registration → 6. Bone surface registration → 7. Gap Assessment → 8. Navigation osteotomy and verification







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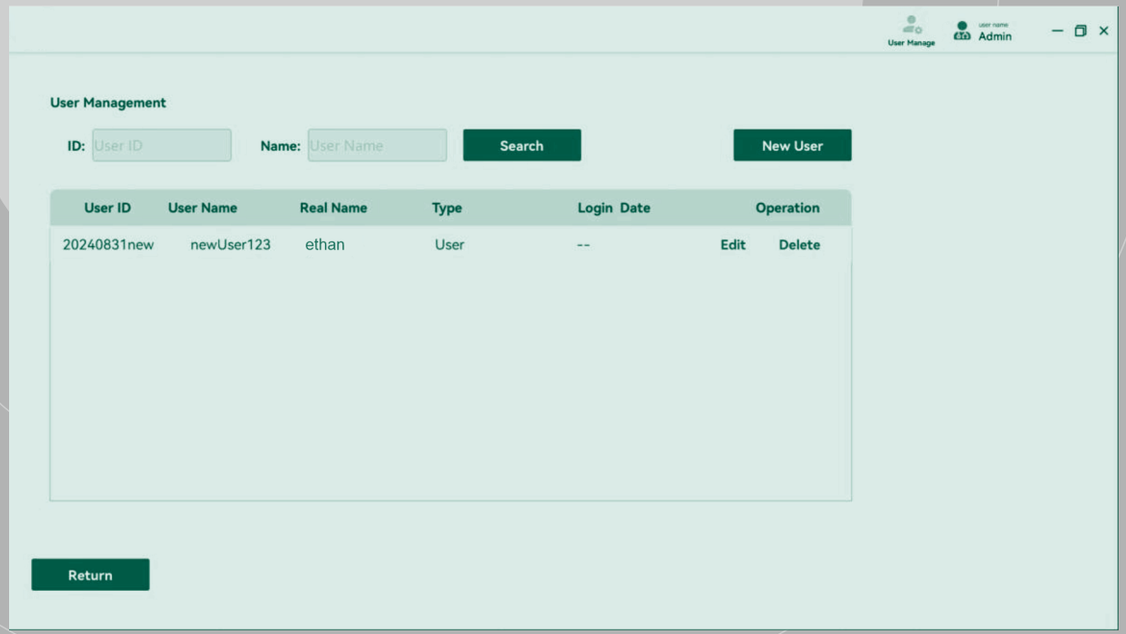
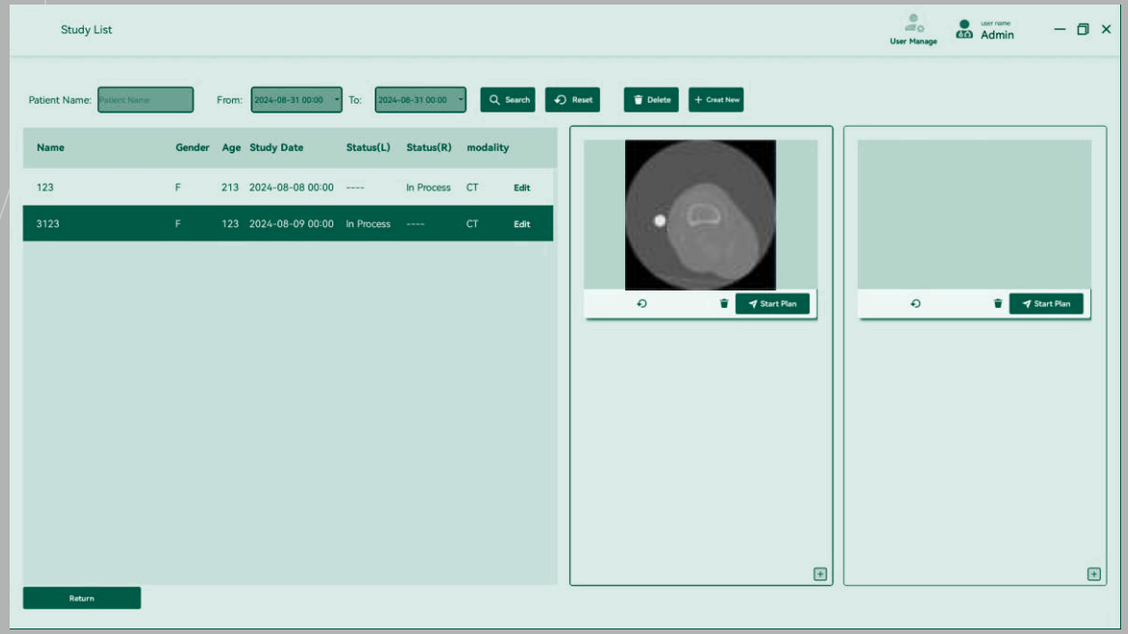
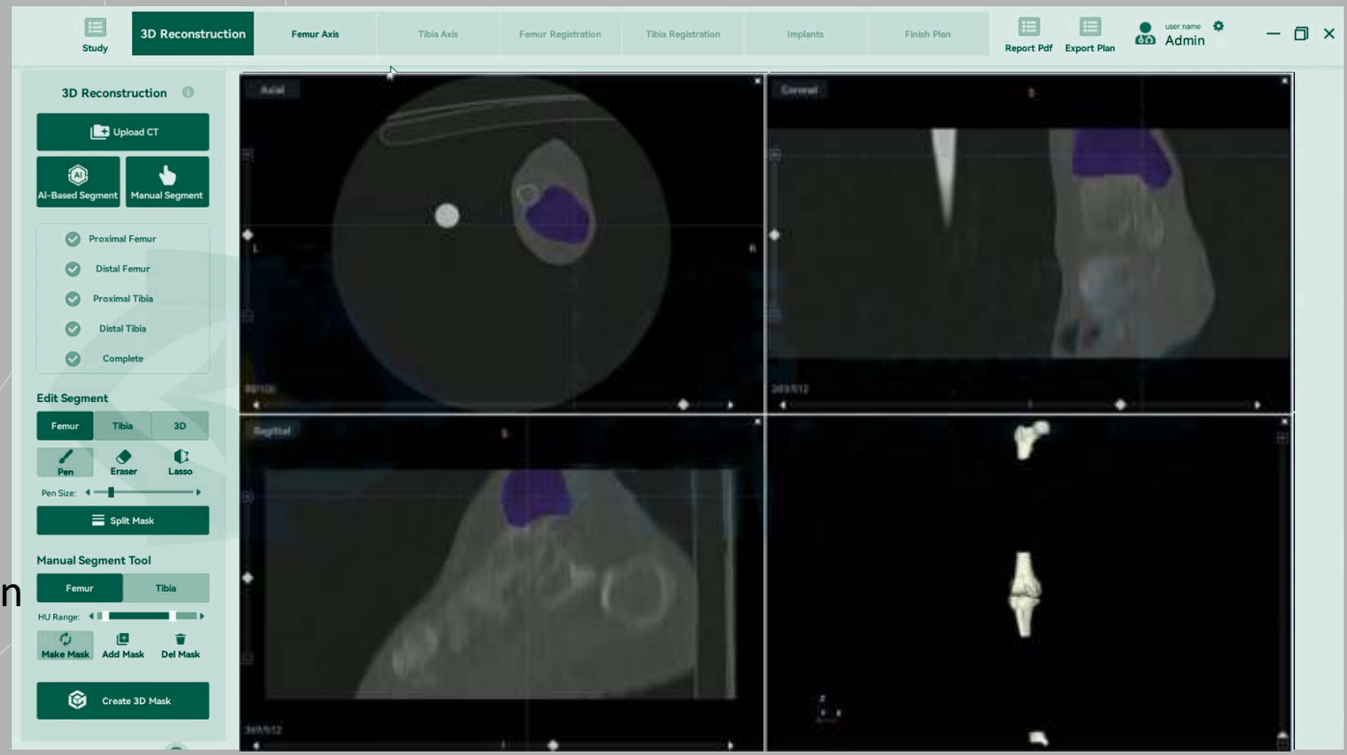
# 1. User/Patient Management



## 2. Image processing

| | |
|---|---|
| Segmentation | • Dicom image analysis<br>• Dicom image display<br>• Image segmentation |
| 3D reconstruction | • Bone reconstruction |

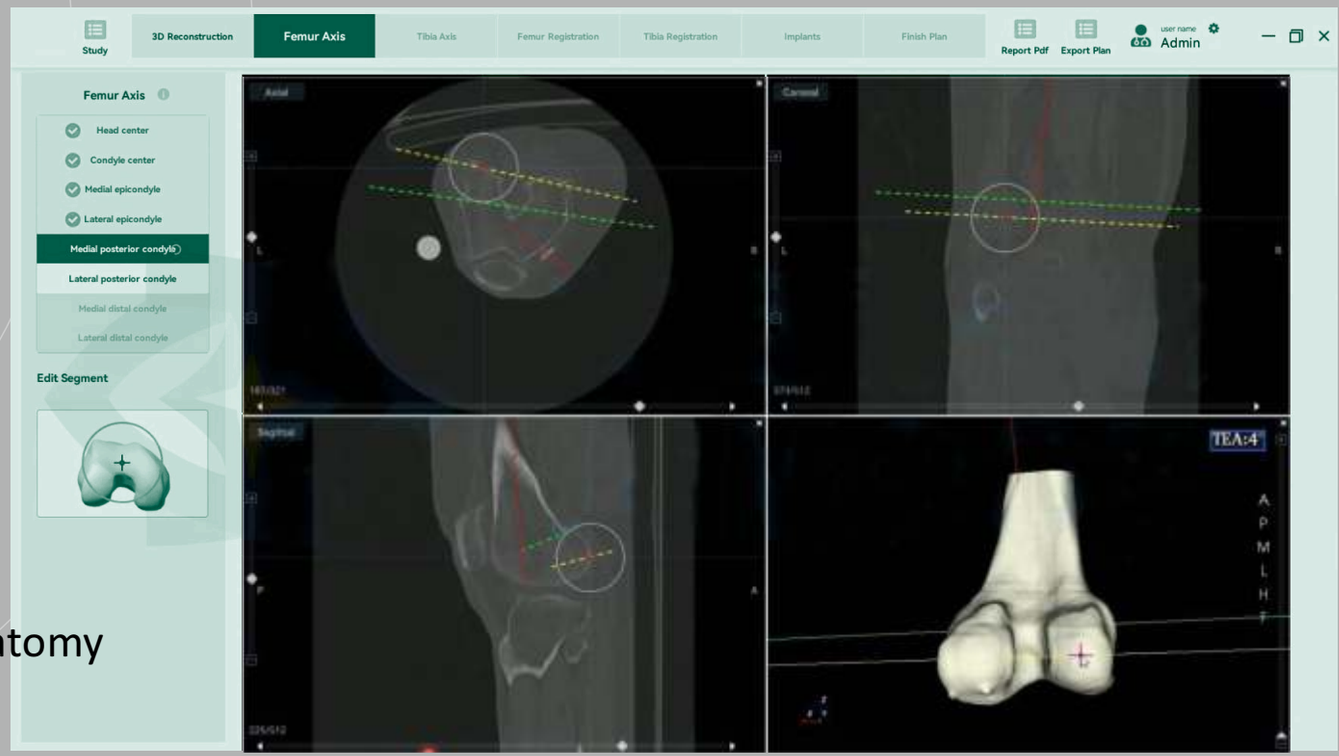



**Preoperative Planning process:**

- **CT scan** before surgery.
- **Segmentation**: CT data is loaded and process in the software.
- Landmark identified and 3D virtual is created.
- **Pre-plan** implant size, alignment, and optimal bone resection.

# 3. Anatomical point/axis location

| | |
|---|---|
| Anatomical Points Positioning | • **Automatic positioning:** Femoral anatomical points Tibia anatomical points<br>• **Supports manual adjustment in 2D/3D** |
| Axis positioning | • The important axes of the femur and tibia can be automatically generated through anatomical feature points |

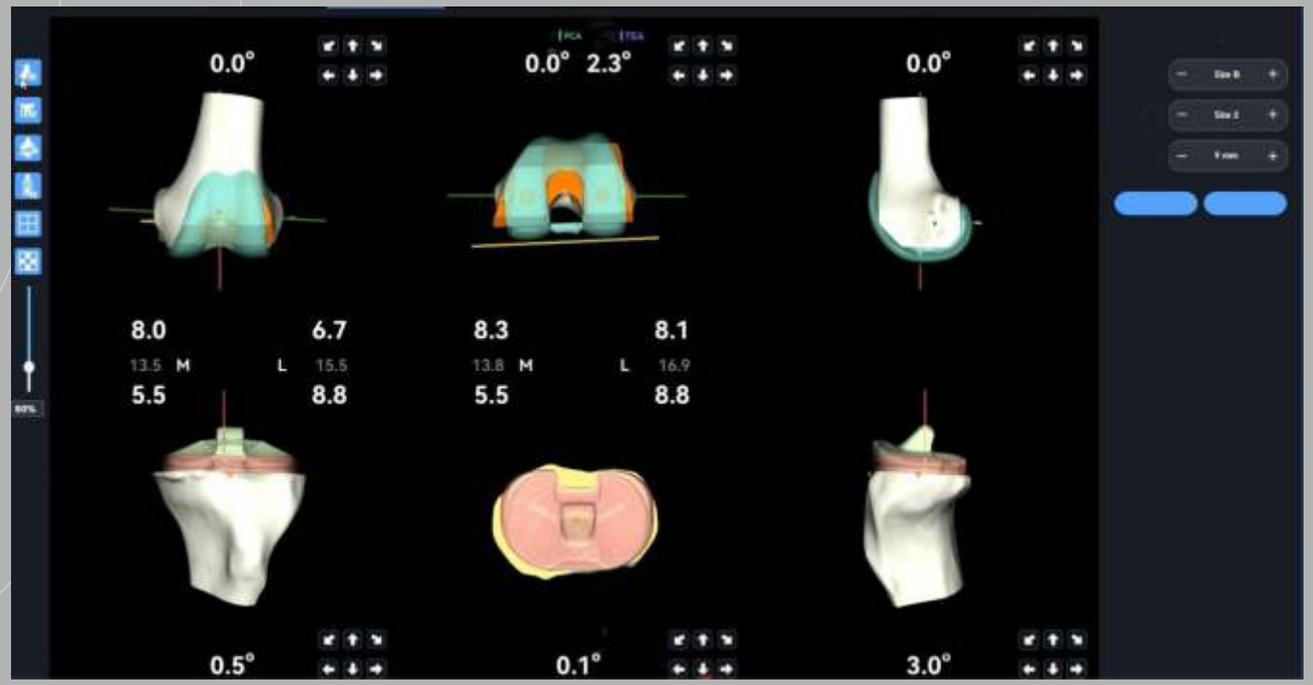



Registration: Ensures that the patient's real anatomy matches the preoperative 3D model.

Alignment: Helps surgeons position implants or tools with millimeter precision.

# 4. Prosthesis planing

| | |
|---|---|
| Prosthesis planning | • Gernerate prosthesis library: can be integrated with different brands.<br>• Automatically recommend planning positions<br>• Manually adjust prosthesis is allowed<br>• Osteotomy surface calculation automatically |
| Planning generation | • Generate the prosthesis plans |

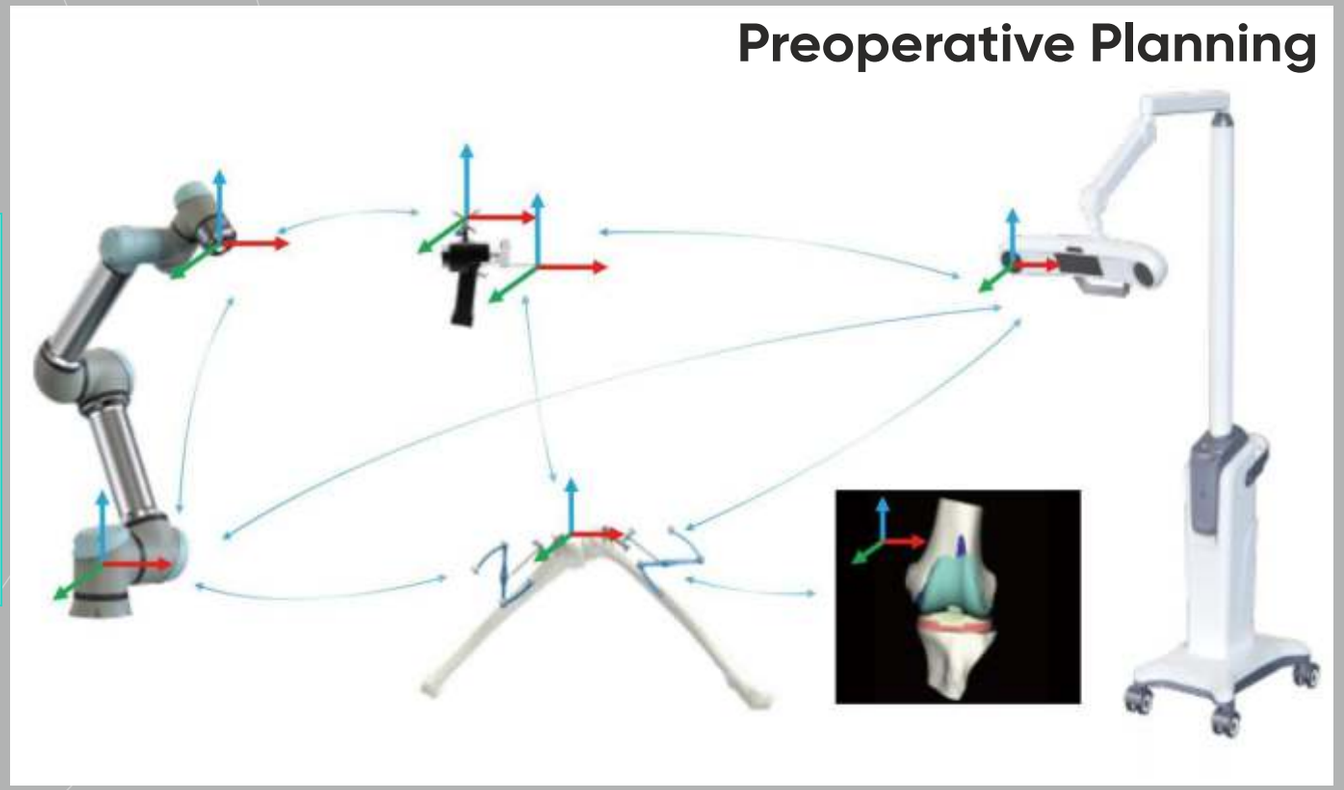



The software allows adjustments to:

- Implant position and size
- Bone cuts and angles

# 5. System Registration

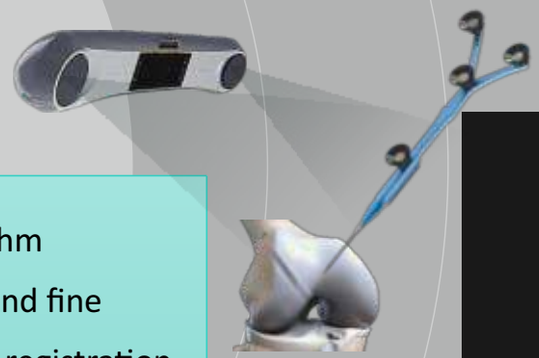
| | |
|---|---|
| System Registration | • Hand-eye calibration<br>• Tool registration<br>• Guide plate registration<br>• Reference pin registration |

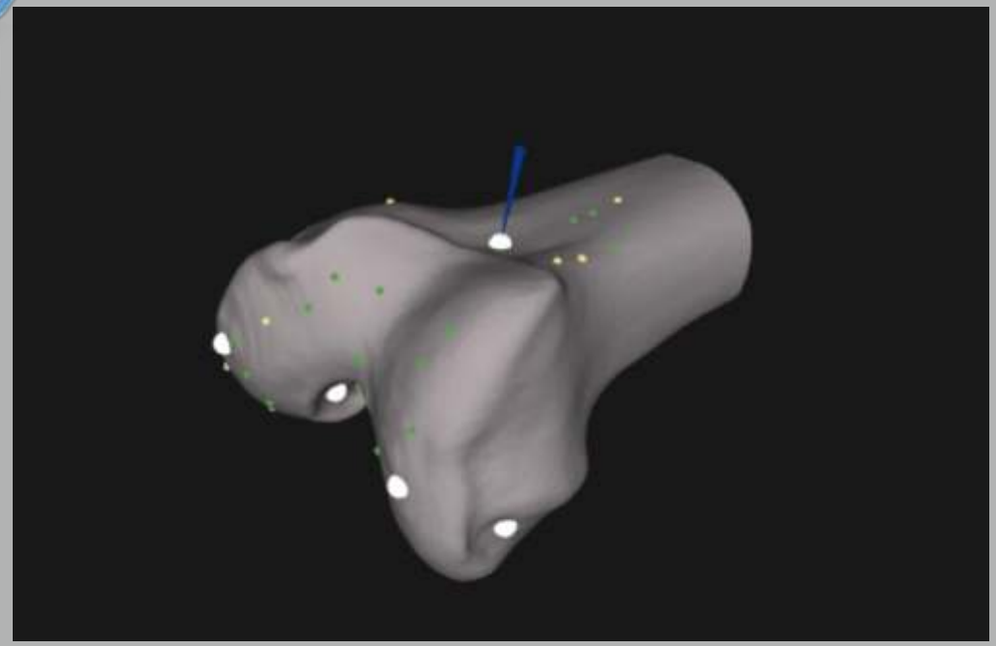



This is the process of aligning the robotic system’s coordinate system with the patient’s anatomy and surgical tools to ensure precise tracking and execution during knee replacement surgery.

# 6. System Registration

Intraoperative





| | |
|---|---|
| Bone surface registration | • Point cloud registration algorithm (including coarse registration and fine registration) to perform spatial registration of CT data and patients<br>• Registration accuracy verification |

The surgeon touches multiple points on the bone surface using a probe. Then the system will match these points with the preoperative CT scan.

It is for aligning the patient's real anatomy with the robotic system's virtual model and ensures precise implant placement

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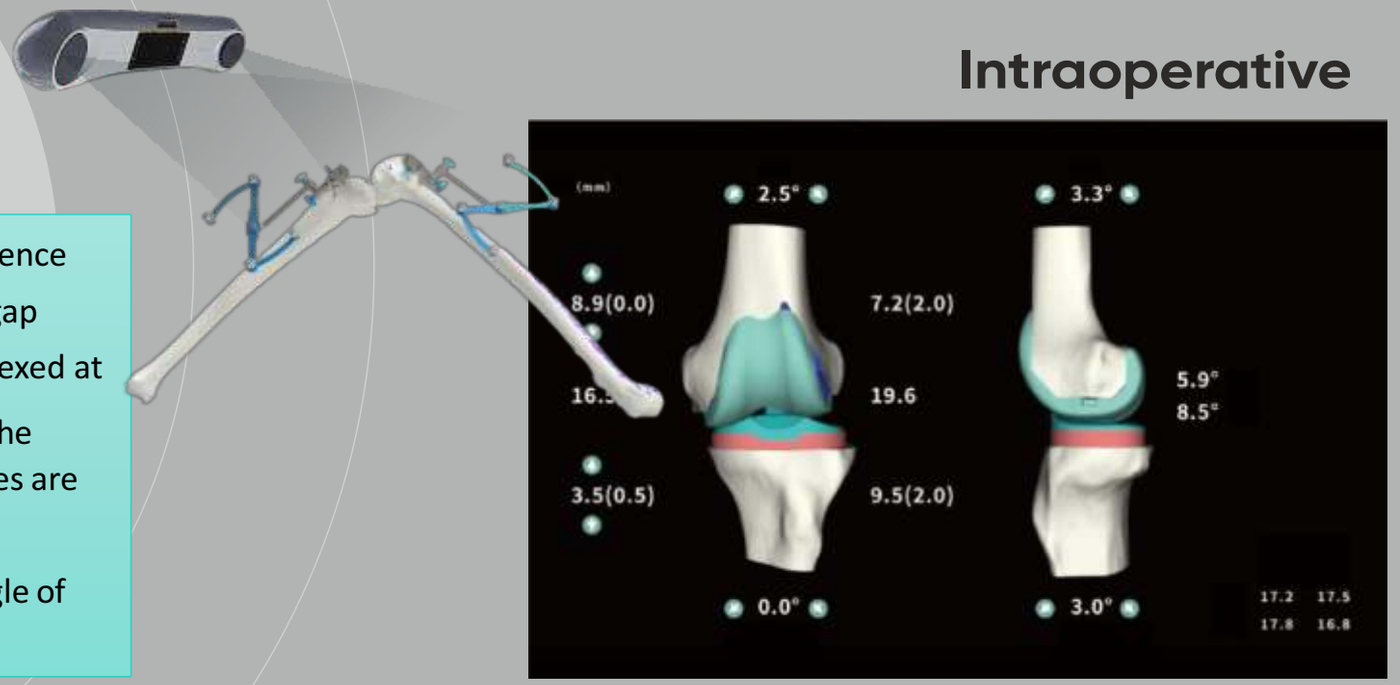
## Intraoperative

# 7. Gap Assessment

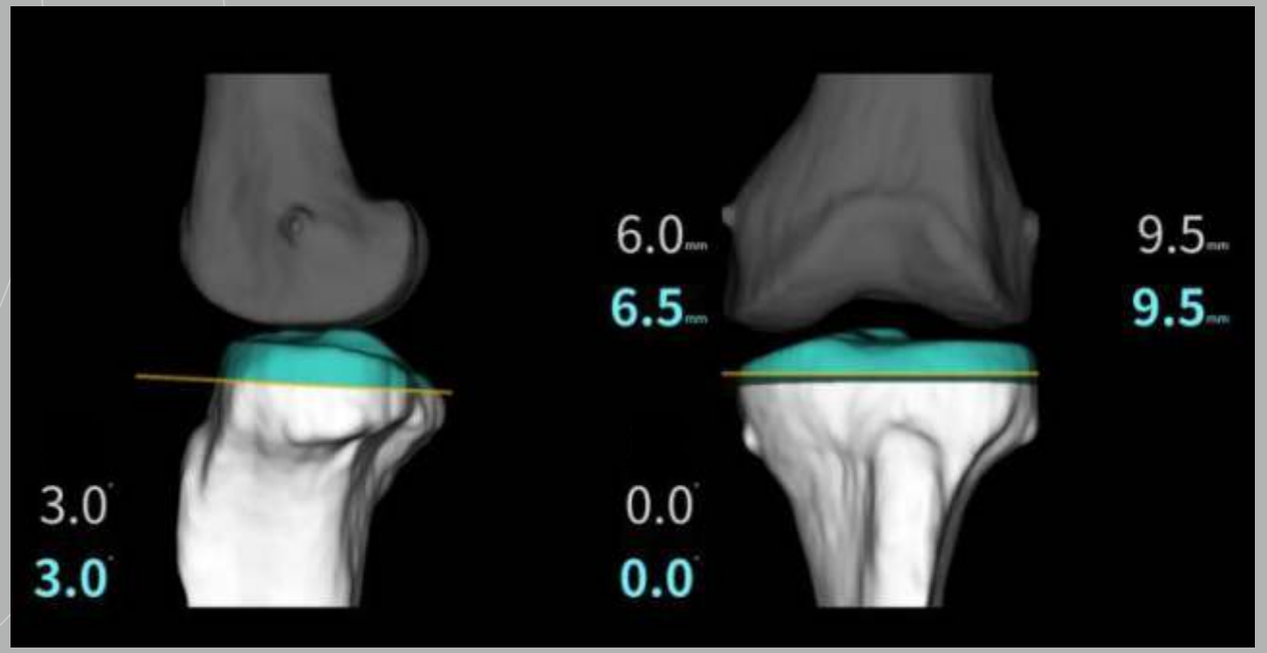
| | |
|---|---|
| Gap Assessment | • By capturing the femoral/tibia reference frame, the medial and lateral joint gap values when the knee ligaments is flexed at 90°, the doctor can judge whether the current medial and lateral soft tissues are balanced.<br>• Manually adjusting the position/angle of the prosthesis is allowed |




- Enhances Soft Tissue Balance – Reduces instability and post-operative pain.
- Optimizes Implant Positioning – Leads to better long-term knee function.
- Improves Accuracy – Real-time data minimizes surgical errors.
- Personalized Surgery – Adjustments are tailored to the patient's specific anatomy.

# 8 Gap Assessment

| | |
|---|---|
| Navigation osteotomy | • The robot arm drives the osteotomy guide to the designated position, and the doctor uses an oscillating saw to perform osteotomy. |
| Verification | • The results of the osteotomy surface can be verified during surgery<br>• Trail implants are installed<br>• Clinical accessment<br>• Final adjustment<br>• Verfify with probe |




Higher Surgical Precision&Improved Implant Fit & Alignment .

With the intraoperative plan,doctor guides the robotic cutting tool (a precision saw) connected to the end of a robotic-arm across the bone surfaces, removing the planned volume of bone resection.

The system ensures precise depth, angle, and alignment during cut.

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## 5 Summary

Why Choose Zeugma ?

- ✓ Zeugma provides a customized OEM solution.
- ✓ Zeugma provides the high-accuracy tracking system for surgical robots.
- ✓ Zeugma provides software services for faster Development and Reducing R&D time for manufactures by up to 50%.
- ✓ Customized Software - Integrated with the cilent's instruments/ implants.
- ✓ Global Standarts : CE, and ISO13485
- ✓ Zeugma provides highly cost effective.

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