Centro de Computación Gráfica
Ciencias - U.C.V

CIMENICS
Hotel Belensate, Mérida - Venezuela

Digital Preoperative Planning for Long-Bone Fractures

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Introduction

- Nowadays, digital images are a fundamental base to medical diagnosis
- CAD (Computer Aided Diagnosis) systems provide support in preoperative surgery planning
- CAOS – Computer Aided Orthopedic Surgery

Preoperative Planning

- It helps estimating the final result of the surgery
- It consists of a trace of the fracture, the steps to follow during surgery and the implant to be used
- Often the tracing is done manually in paper

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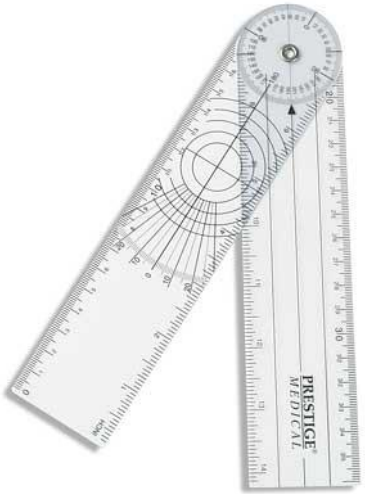

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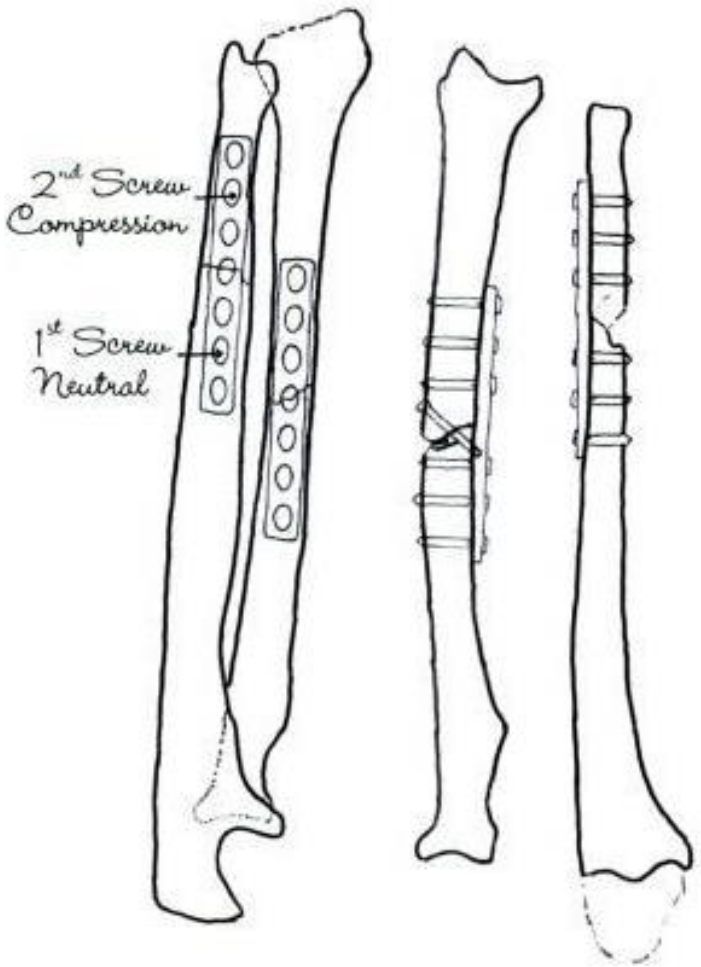
Preoperative Planning



Pre-Op Plan

1. Supine/Arm table / Tourniquet No Exsanguinatio
2. "Henry's" (Anterior) Approach to Radius
3. Expose fx Ø stripping "Specials : Dental pick
4. Reduce → Interfragmentary screw
5. Neutralization plate - 7 hole LCDC plate
   (leave central hole open)
6. Ulnar - approach to ulna : ECU/FCU interval
7. Reduce "Make sure no comminution on
   interosseous membrane!
8. Compression Plate
   - Screw #1 - Hole 6 (proximal) in neutral
   - Screw #2 - Hole 2 (distal) in compression
   - Fill holes 1/3/5/7 neutral
9. ✓ Flouro + full ROM
10. Close subcut & skin (Drain if needed)
11. No splint

CAOS system

- Manual procedure (pen-paper) consumes long time
- Manual procedure is error-prone
- Instead, CAOS systems are used in many healthcare centers
- CAOS systems make **digital planning** possible

Then, our proposal is

Eliminate the pen-paper method

Build a low-cost CAOS solution

Special hardware must not be required

Proposed Scheme

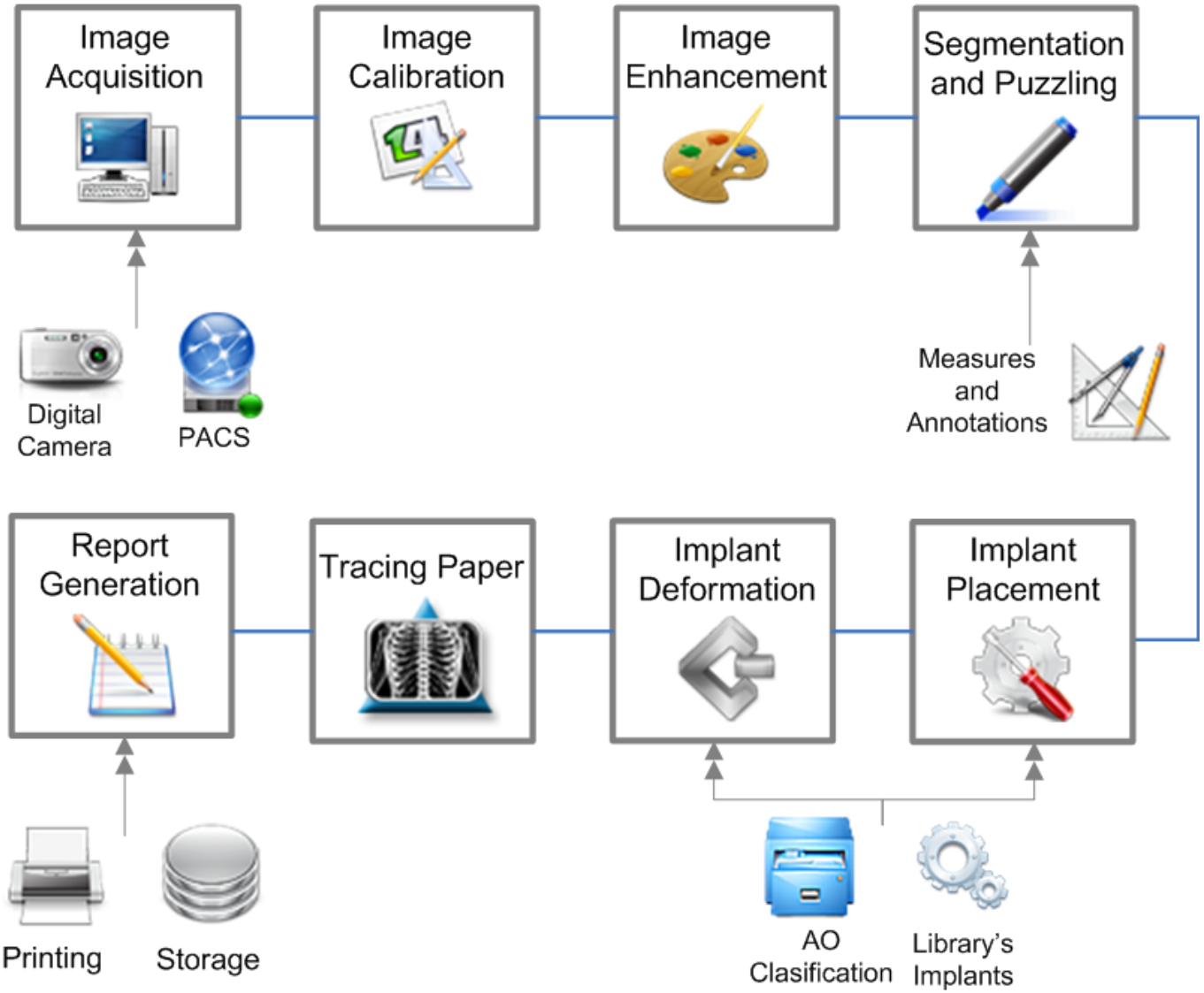


Image Acquisition

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digital format

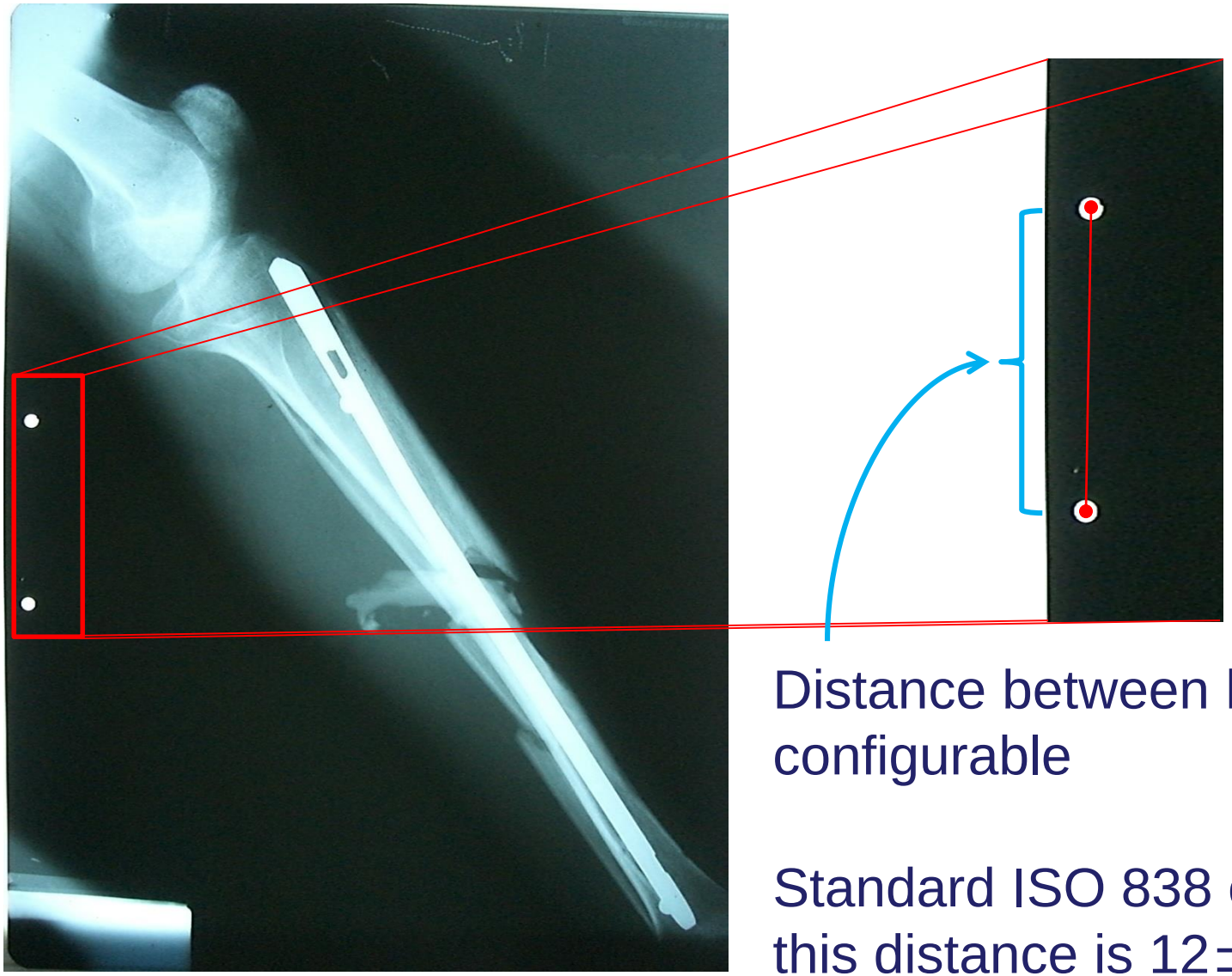
Prerequisites

Controlled environment (lighting, distance to shoot)

Resolution of at least 800x600 pixels (0.5 megapixels)

Focus in the area of interest (i.e. the fracture)

Image Calibration



Distance between holes is configurable

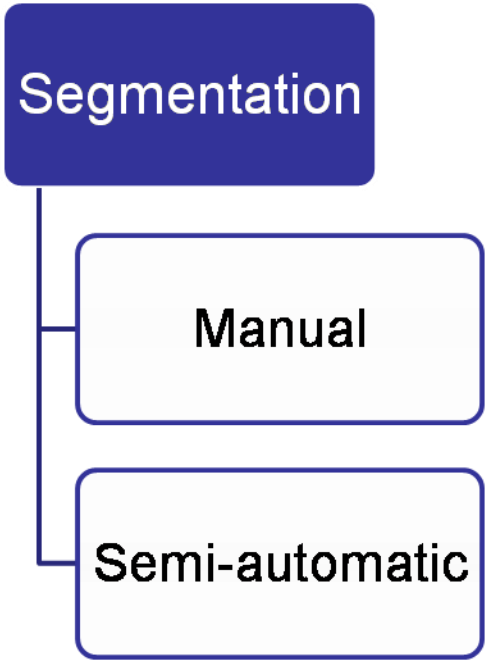
Standard ISO 838 establishes this distance is 12±1 mm

Image Enhancement

- Necessary to obtain a better image contrast
- Manual window/level adjustment

Segmentation and Puzzling

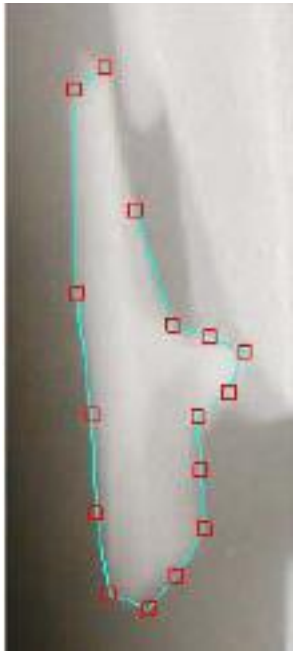
- **Segmentation**: Extract from the image all bone segments separated by the fracture
- **Puzzling**: Place these bone segments in their anatomically correct positions using translations or rotations

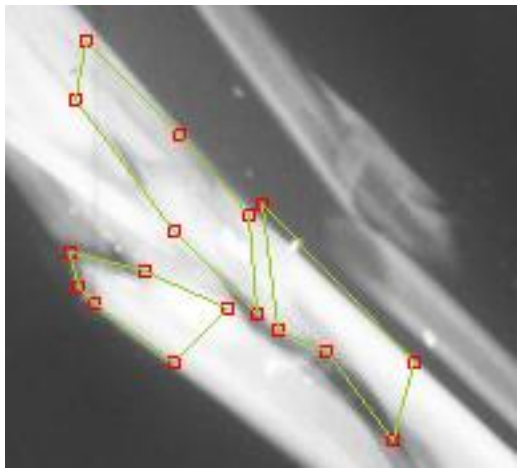


In manual mode, the surgeon has full control over the segmentation

In semi-automatic mode, a Canny border detection algorithm is used to find the border of each bone segment

Segmentation and Puzzling





A fracture would produce many bone fragments

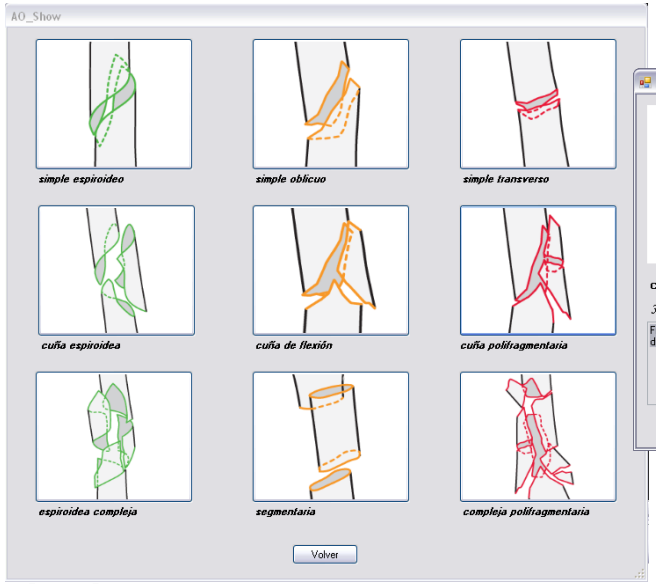
The measurement tool is very useful to calculate the length of the bone, the length of the implant, etc.

For a later reviewing, different annotations should be written

Not all segments fit exactly in their correct anatomical position, a very close approximation is enough for planning

Implant Placement

- When the puzzling process is completed, the surgeon decides whether to put an implant on the patient or not
- A library of implants is provided, including: plates, screws and pins
- MySql® is used to store information about implants
- Each implant is represented using a STL file which stores the 3D triangulated surface of the implant
- A complete library of AO[2] fractures is also available



Implant Deformation

- In some cases, surgeons might need to bend an implant
- The implant deformation process is useful to plan the bending operation over the implant during the surgery
- At the surgery room, the surgeon applies a deformation over the implant using a specialized groove plier
- Our system allows the digital deformation of the implant prior to the surgery

Tracing Paper and Report Generation

- Finally, the system can print out the tracing paper and a report that includes: annotations, measurements, fragments of bones, etc.

At this point, the preoperative planning is complete!

HOSPITAL CLINICO DE CARACAS

DEPARTAMENTO DE RADIOLOGIA

DR. CARLOS SANCHEZ

PACIENTE: LUIS PERRAZO EDAD: 45 PESO: 78 FECHA: 01/11/2009

ENTRADA: PACIENTE RECIBIDO POR FRACTURA TIPO 32-A3

TACTICA A EMPLEAR:

QUITAR EL TORNIQUETE

LIMPIAR LA ZONA

APLICAR CORTE TIPO 4 BAJO ANESTESIA LOCAL

SELECCIONAR EL IMPLANTE ESCOGIDO

NO APLICAR DOBLAMIENTO

RECONOCER LOS LIGAMENTOS COMO AREA DE SEGURIDAD

COLOCAR EL IMPLANTE SIN ARRAIGAMIENTO PARCIAL SINO TOTAL

REQUIERE DE IMPLANTE EXTERNO. UNA PLACA DEL TIPO DCP ANATOMICA MARCA XXX COLOCADA A 5MM DEL SEGMENTO DIAFISIAL

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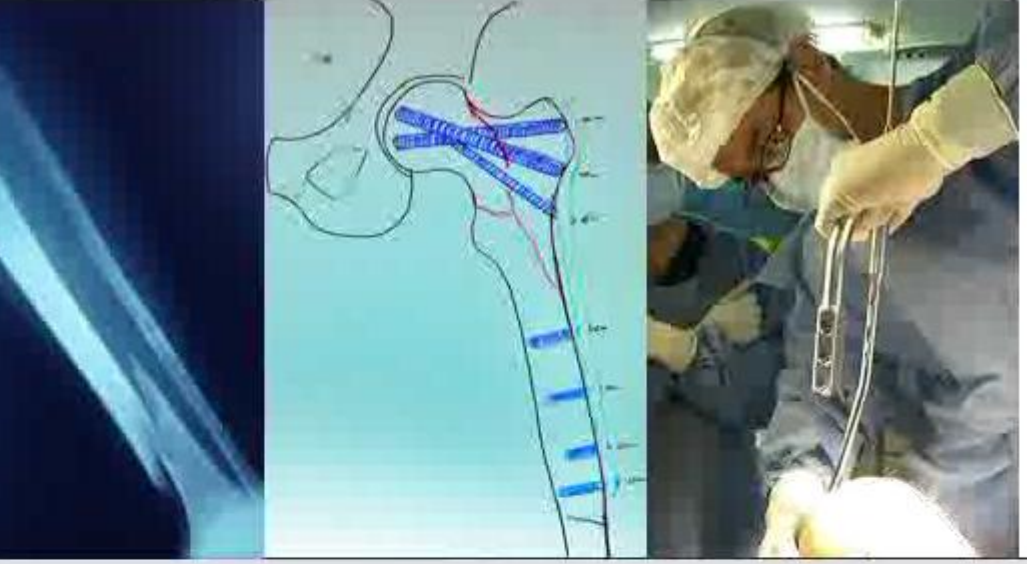
Results and Conclusions

- We installed our system in a standard PC without specialized hardware at the Radiology Department of the HUC (University Hospital of Caracas) in Venezuela
- Two experts were instructed on how to use the system in a short time
- Without the system, the surgeons create a preoperative planning manually in 8 to 25 minutes approximately
- With the system the planning time varied from 2 to 5 minutes
- That represents a considerable reduction of the planning time and positive feedback about results of the system

Future works

- Implementing a better border detection algorithm, e.g. algorithms based on active contours or deformable models
- Extends our system to support others object of reference
- Take advantages of current technology to speed up the annotation process, e.g. using speech recognition tools, medical tablet PC's, etc.



UNIVERSIDAD CENTRAL DE VENEZUELA

PLANIFICACIÓN PREOPERATORIA

TRAUMATOLOGIA Y ORTOPEDIA

VERSIÓN 1.0 - 2009

ESMITT RAMIREZ, CARLOS SANCHEZ

Realizar Planificación

Clasificación AO

Biblioteca de Implantes

Generar Reportes

Base de Datos

Configuración

Modificar

Salir

Questions

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