Università degli Studi di Pavia

Dipartimento di Ingegneria Civile e Architettura (DICAr)

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Analisi dei parametri di utilizzo della *console* chirurgica Da Vinci® tramite elaborazione di segnali video

Laurea in **Bioingegneria**
A.A 2012/2013

Presentazione di **Erika Negrello**

Da Vinci SI Surgical System

At **I.R.C.C.S Policlinico San Matteo – DEA**

Three main components:

Surgical Console → Surgeon's Workspace

Robotic Arms → Operating Component

Vision Carriage → Connection Unit

Advantages:

- Patient Outcome
- Fast Learning → training with Dual Console System
- Ergonomics

Ergonomics in Surgery

How do you get it?

- Strumentation design
- Spatial distribution of the strumentation
- Team's coordination in the operating theatre

LAPAROSCOPY

- Wrong posture (standing)
- eye-hand misalignement
- Few d.o.f.

ROBOTIC SURGERY

Overcoming of ergonomics limits:
ONLY with a correct use
→surgeons training

physical and cognitive stress

Goal

Our Purpose: Acquire information on the **usage of the console**

Final Goal: Provide an evaluation system that

- assess **surgeon experience** in robotic operations
- allows the estimation of a well-structured **learning pattern** in the usage of DaVinci robot

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Maximize benefits of robotic surgery

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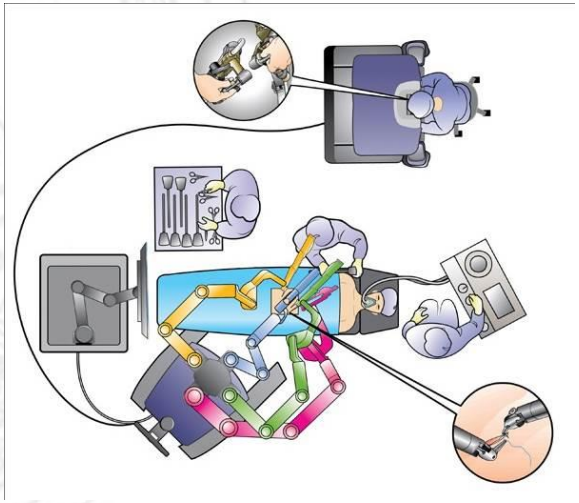
How

1. Detect **surgeon arms movements**
2. Detect the **usage of the console** instruments:
   - **Right Clutch**
   - **Left Clutch**
   - **Camera Pedal**

Monitoring of console instruments

- Acquisition with API Da Vinci → impossibile
- Video signals Acquisition from the robot

Where? In the operating theatre
→ spaces evaluation to avoid interfering with medical staff and equipment
→ ideal position: behind vision carriage (core)



When? During a training session / at the end of a surgical operation

Video Acquisition 1

How? Hardware and software connection between Core – User PC

Core Patch panel with Video Output Connection

S-Video

User PC with
Acquisition Software

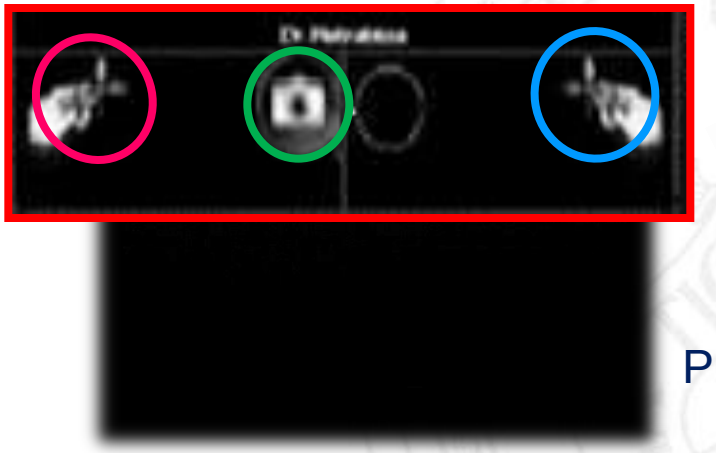
USB

Video Capture Device

Video Acquisition 2

Data Transfer

Touchscreen monitor → video output



PC monitor

Right Clutch

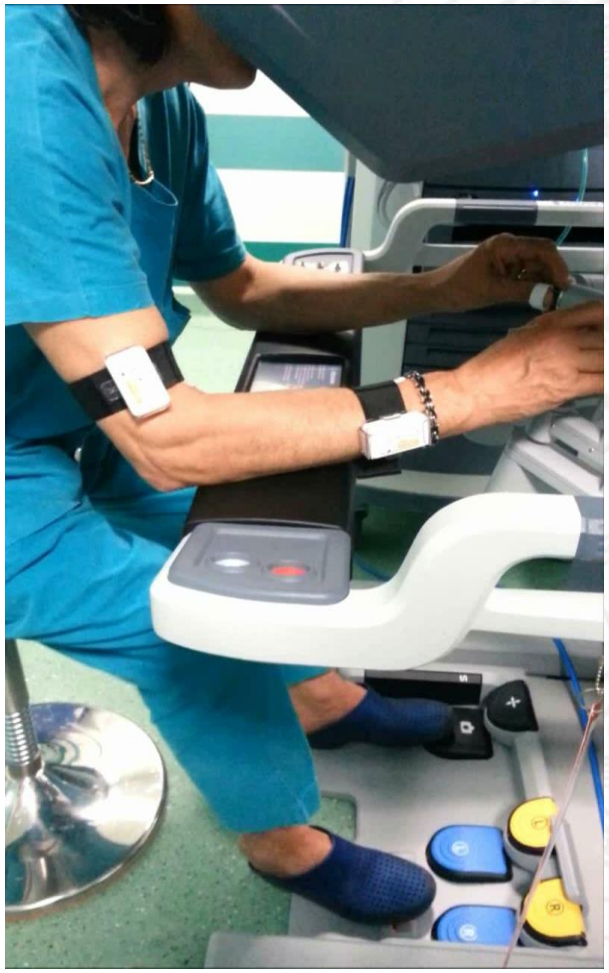
Left Clutch

Camera Pedal

Controllers

Video Signal 1

Surgeon at the console



Acquired Video

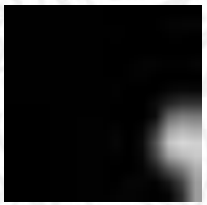
Video Signal 2

Left Clutch

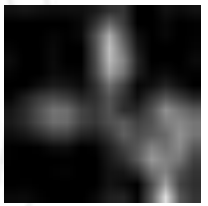
OFF

ON

Right Clutch



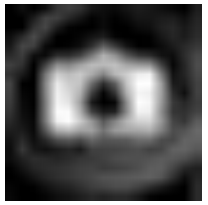
OFF



ON

Camera Pedal

OFF



ON

Video Processing

Purpose: Icons Change detection in the video → transition **on/off**

Analyse video data through a Matlab routine

Recording Pattern → Recording starts with the simultaneous activation of the three devices

Workflow:

Video Cropping

Video Import in Matlab

Video Processing

Output: Indices of the Console Usage

Implemented Techniques:

- Frame Comparing
- Template Matching

Frame Comparing

Technique Description:

Detect Changes by comparing each frame with the following one

Threshold Setting:

- Mean difference between frames of a video section with only noise
- Mean difference between an 'on' frame and an 'off' frame

Mean = Threshold

Comparison > Threshold	→	CHANGE
Comparison < Threshold	→	NO CHANGE

Problem: Video Initial Flicker→ not to be considered

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Region of Interest's reduction? Not Good

Template Matching

Technique Description:

Detect Changes by comparing each frame with a Model-frame (off) → Template

Threshold Setting:

Threshold = diff_on_off - 0.2*(diff_on_off)

Mean difference between Template and an 'on' frame

percentage → adjustable parameter

Comparison > Threshold	→	ON
Comparison < Threshold	→	OFF

Advantages:

- No Flicker problem
- Recognizes rapid changes

→ More **robust** and **reliable** method

Illustrative Indices of the console usage

1. **Number of uses** (activations) of each instrument during a recording

   →not representative if the instrument is quickly turned on/off many times during a recording → many uses of short duration

2. **Percentage of usage** of each device

   More significant measure of mean usage

Recording Example Results

Time: 96 sec
Frame Rate: 25 fps

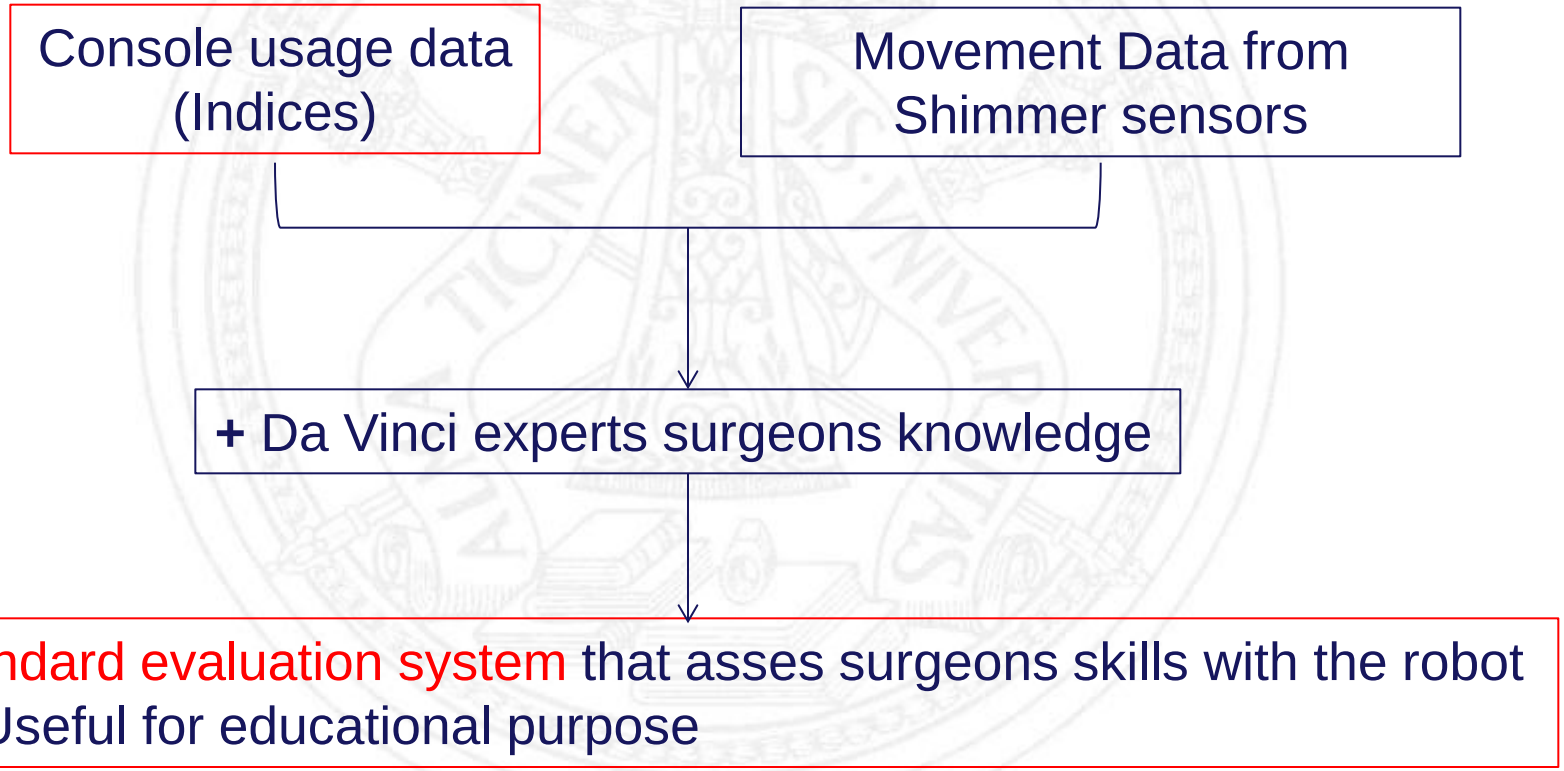
RIGHT CLUTCH:
1. Number of activations = 4
2. Percentage of usage = 2,9%

LEFT CLUTCH:
1. Number of activations = 4
2. Percentage of usage = 2,3%

CAMERA PEDAL:
1. Number of activations = 2
2. Percentage of usage = 16,3%

Next Steps

1. Make a video recording during a real surgical operation → verify the strength of the algorithm

2. 

THANKS FOR YOUR ATTENTION

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