Let´s begin to process your idea for work on

Signal and Image Analysis

of this semester

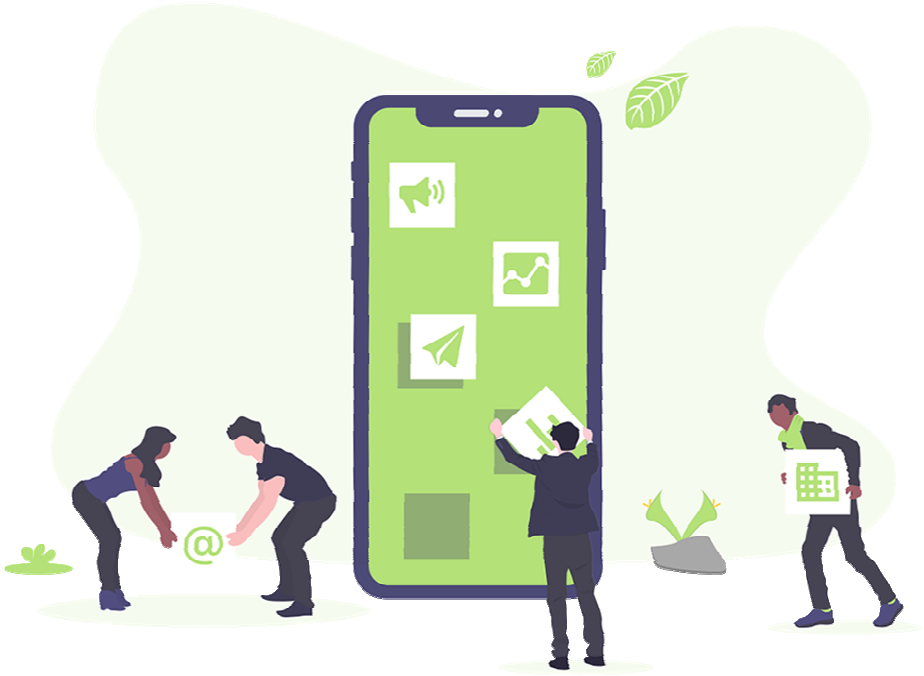
Aura Conci

http://www.ic.uff.br/~aconci/PISB.html

Visual Lab - Abril 2022 - Institute of Computing

IC/UFF

Fluminense Federal University



I try to do sugestions for your work

In order that the idea in your proposal of the work have a first approach until the end of our course of this semester !

- At any time , please , include observations or mention related aspects of your group and activity .

- The proposal is implement it until the end of next moth.

Agenda for next class:

27 of April - each person or group present what is the next steps related to do the:

1 - Features computation (why the f**eatures** are chosen) .

2 - Steps that will be follow in the **processing phase** .

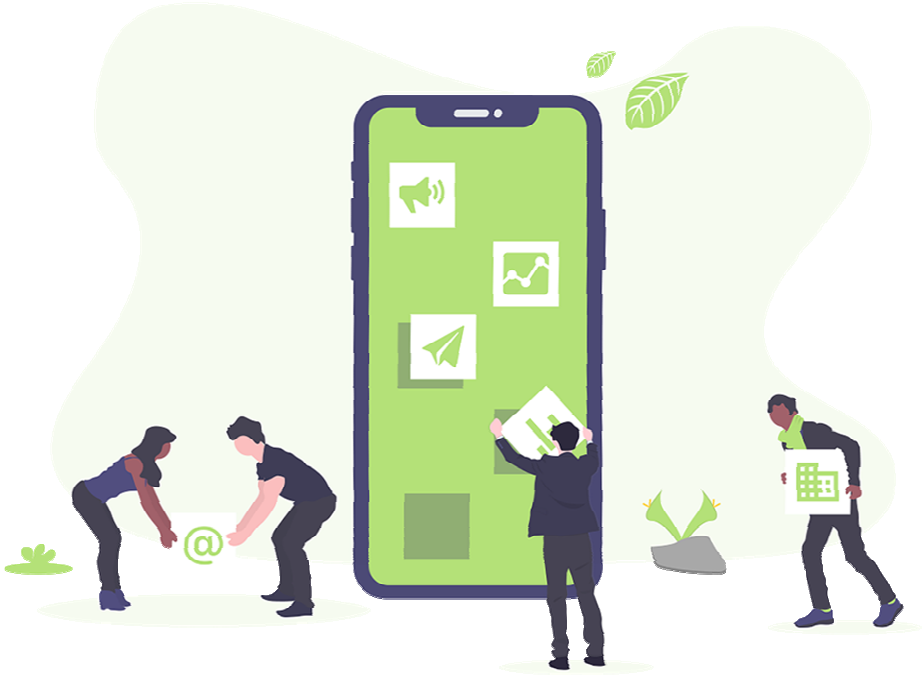
3 - What is considered a **solution** for the initial problem .

4 - What is the **input** ?

5 - How is the **output** ?

6 - How will be the **evaluation** of the soution ?

7 - What will be the **computational tools to be used ?**



Aims until end of May

- **Desing a possible solution ; (for April 27)**
- **Implement this for solving your problem (first version May 4) ;**
- **Second version with improvements and results (May 11) ;**
- **Report this researche propely and results comparisons (May 18) ;**
- **Organize it as a conference paper (May 27) to be submitted in some conference of Signal and Image as:**
  - **35th SIBGRAPI 2022 (Natal – July 3) !**
  - **Or (**CLEI SLCGRVPI 2022 - Latin America Simposium of Computer Graphics, Virtual Reality and Image Processing)

ok ! so...

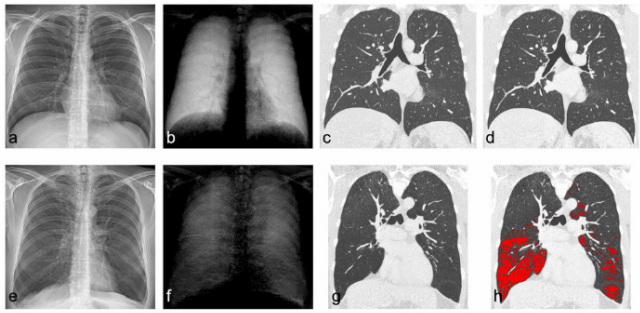
Samples of features & processing steps:

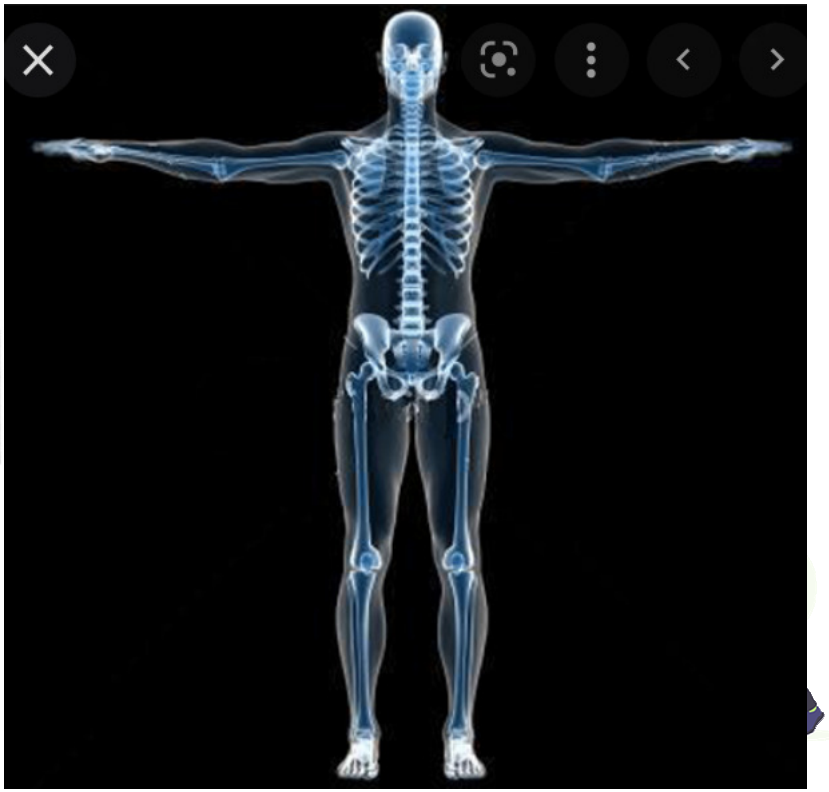
Case 1 – Augusto´s (acknowledging the book he send us)

New identification of body parts from common x-ray

Dark-field chest x-ray imaging

Over the past decade, dark-field radiography, a novel x-ray imaging technology, has been under development. This cutting-edge technology, that can provide information about the microstructural integrity of the lungs, was utilized in this study for the evaluation of emphysema in patients with alpha1-antitrypsin deficiency.





Samples of RADIOGRAPHY

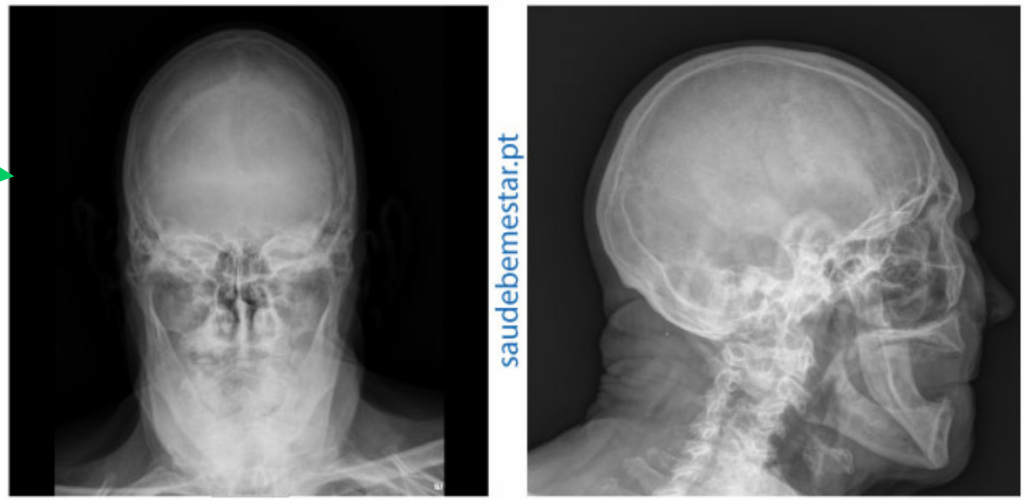
Oral x- ray (teeth)

•Diverse angles - > but lines mainly in 2 directions

•Head (all directions almost the same number)

•Combining edges detection
•+ HOG +
•Multi class SVM for classification using
•Initially 2 images of each class

•Example:
https://www.mdpi.com/1424-8220/21/14/4802



Example for Augusto´s proposal

The input is a DICOM file and the output is an integer corresponding to the category related to the body part.

1- **Preprocessing :**

1.1 - Open & reading the **DICOM file**,

1.2 - Extracting the **jpeg** image from the DICON

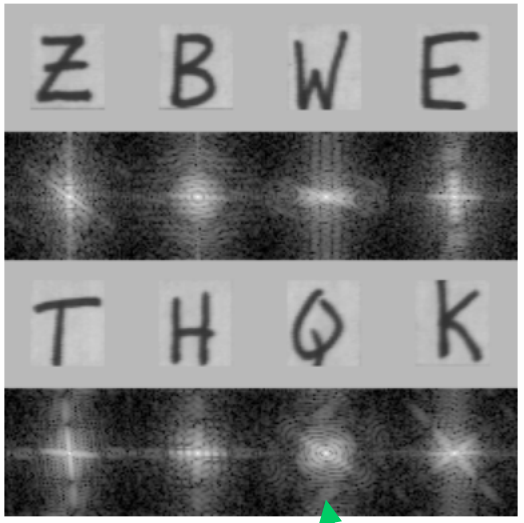
2- Processing :

2.1 - **Edge detection** using direction and **non directional** approaches

2.2 - Compute the **Histogram of Oriented Gradients - HOG**

HOG - Represent the numbers of edges in each direction of the images (how many directions is important: from horizontal to vertical edges in order to do the numerical output referring to the classification?

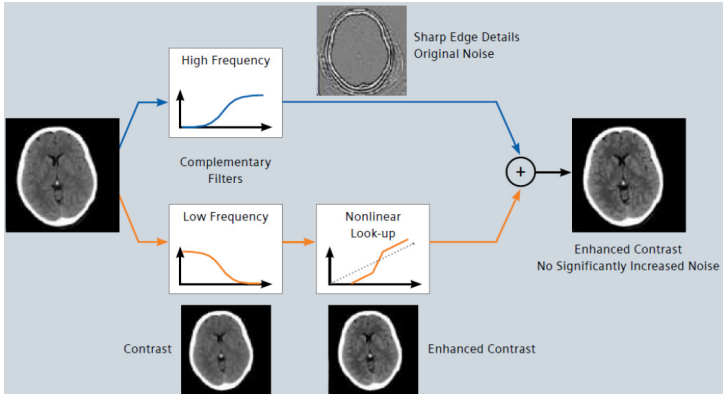
degrees interval



Why could the Fourier transform + the Fourier spectrum construction be not a good idea?

LET´S SKIP THE PREPROCESSING , OK?

FOR ALL OF YOU (INITIALLY)



OBS.: X Rays

used for diagnosis of bones

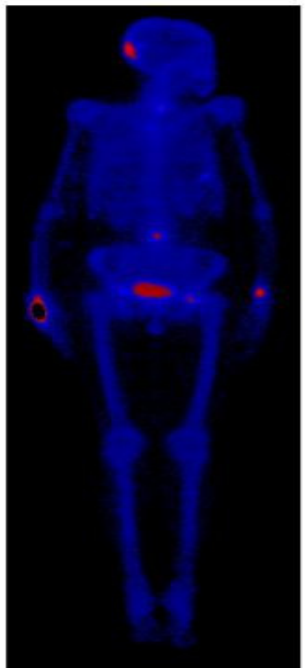
a DICOM (Digital Imaging and Communications in Medicine) file

Support Vector Machines (SVM)

Or

Decision trees
(specifically a variation called Gradient Boosting - GB)

This is very related to the imaging type !
other possible aplications:
Metastases Recognition by scintigraphy



Quantificatio
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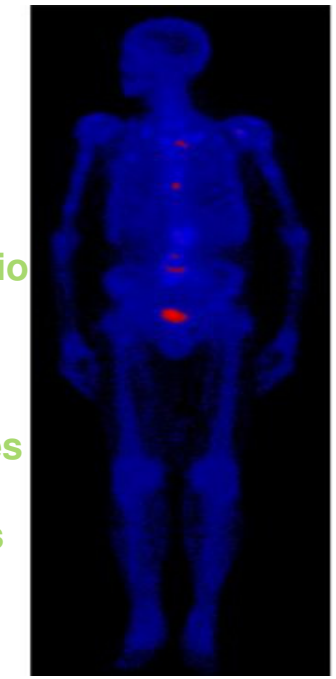
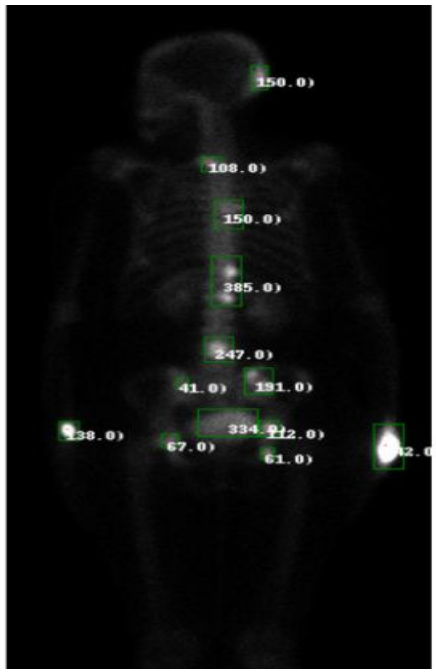
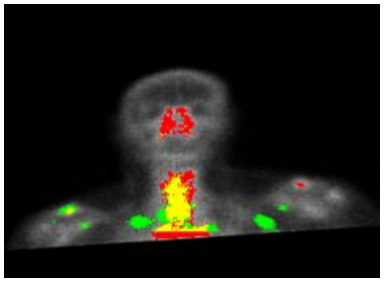
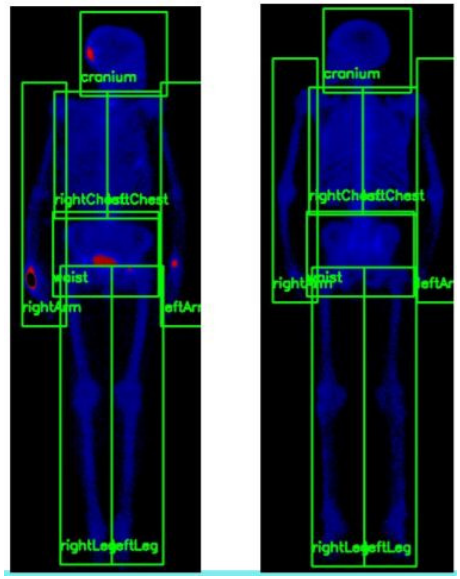
of
Bone
Metastaeses

Gama Rays



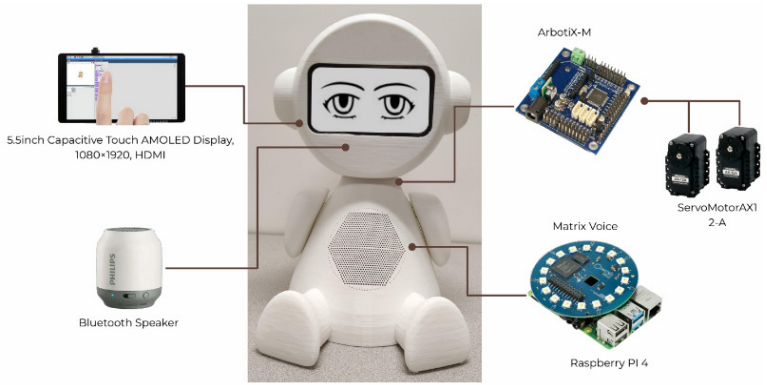






Case 2 – Signal group : Marcelo , Luciana – Robot (Thiago – geological waves - give up ?)

Emotional state by sound waves - > (EVA robot Enhanced Version)



1- **Preprocessing :**

1.1 - Open & reading the samples,

1.2 - Extracting the sound signal from the samples

2- Processing :

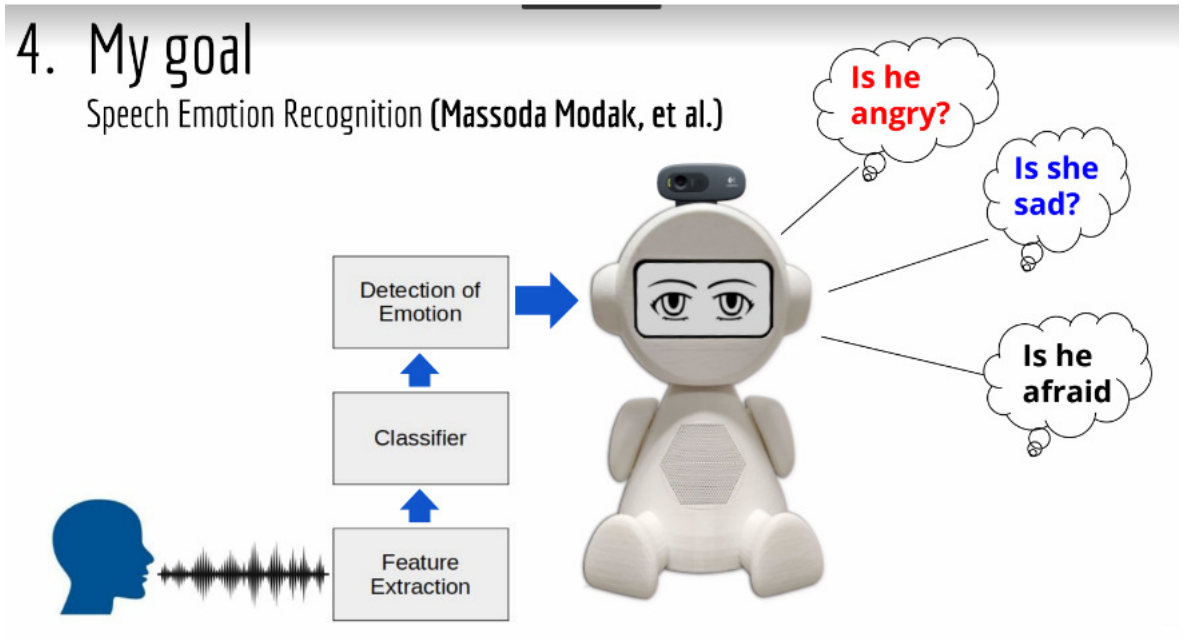
2.1 - Compute features in : TIME domain or/and in FREQUENCY domain :

2.2 – Experiments on identification of these different domains

MUSIC SIGNAL, ONE PERSON'S VOICE, STREET SOUND, SEVERAL PEOPLE TALKING IN NOISY ENVIRONMENT, WAVEFORM CHANGES:

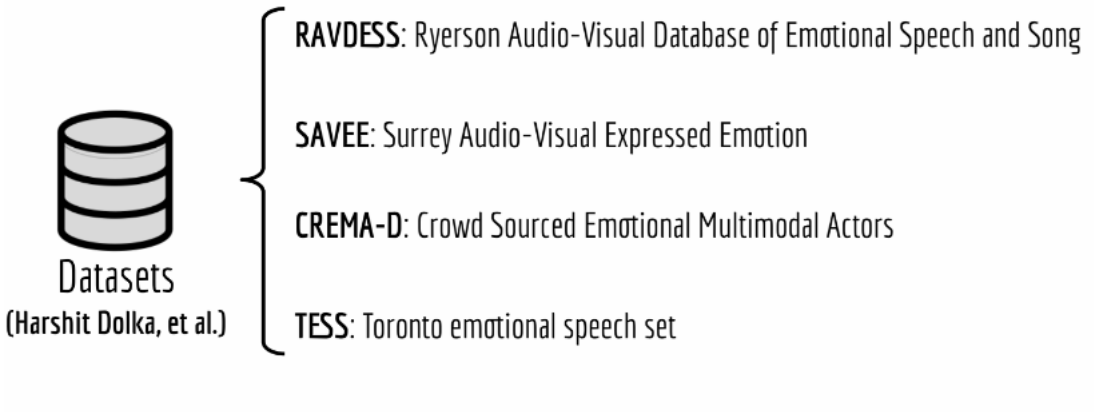
M.S. Fonseca, Combinando Imagem e Som para Detecção de Transições em Vídeos Digitais, M.Sc. UFF. 2006

,

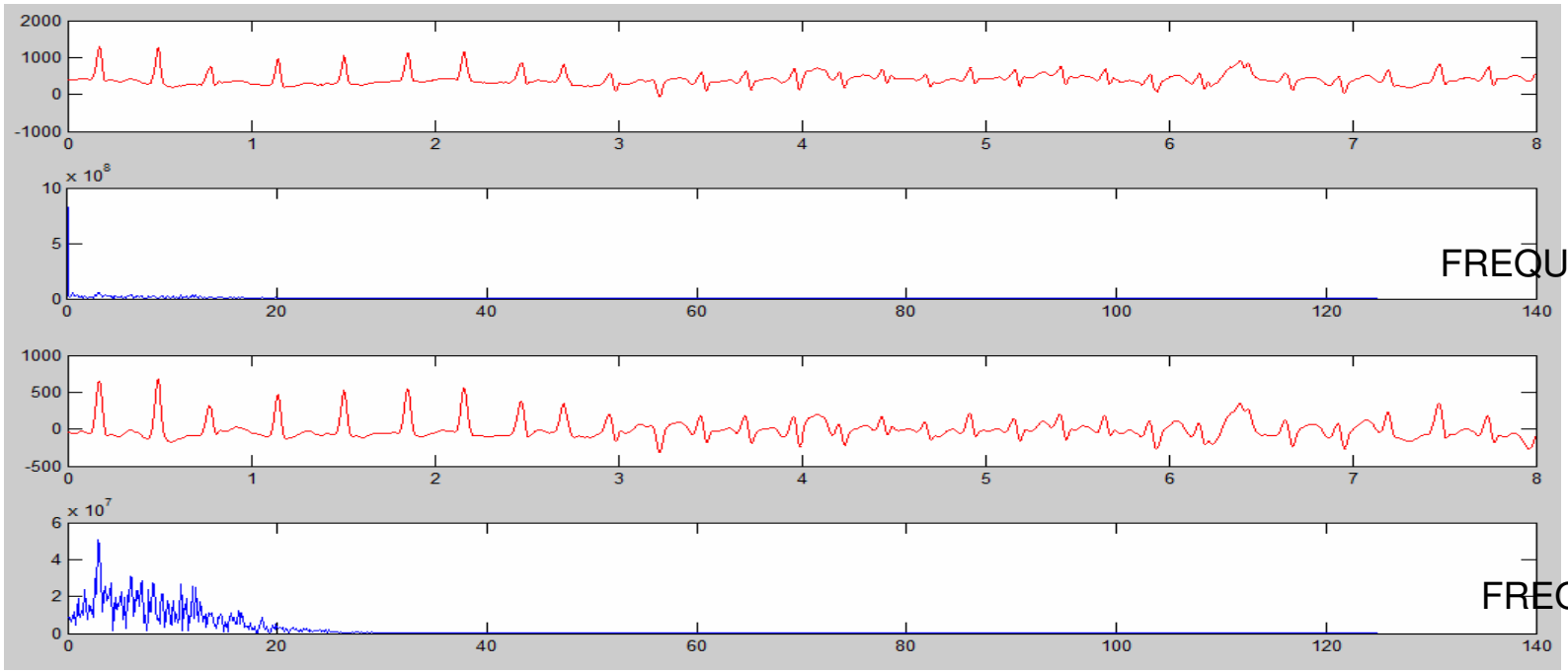


a sugestion

Naïve experiments with
a small data set from one of them



Representation in the TIME domain or in the FREQUENCY domain :
. Fourier Transform



TIME domain

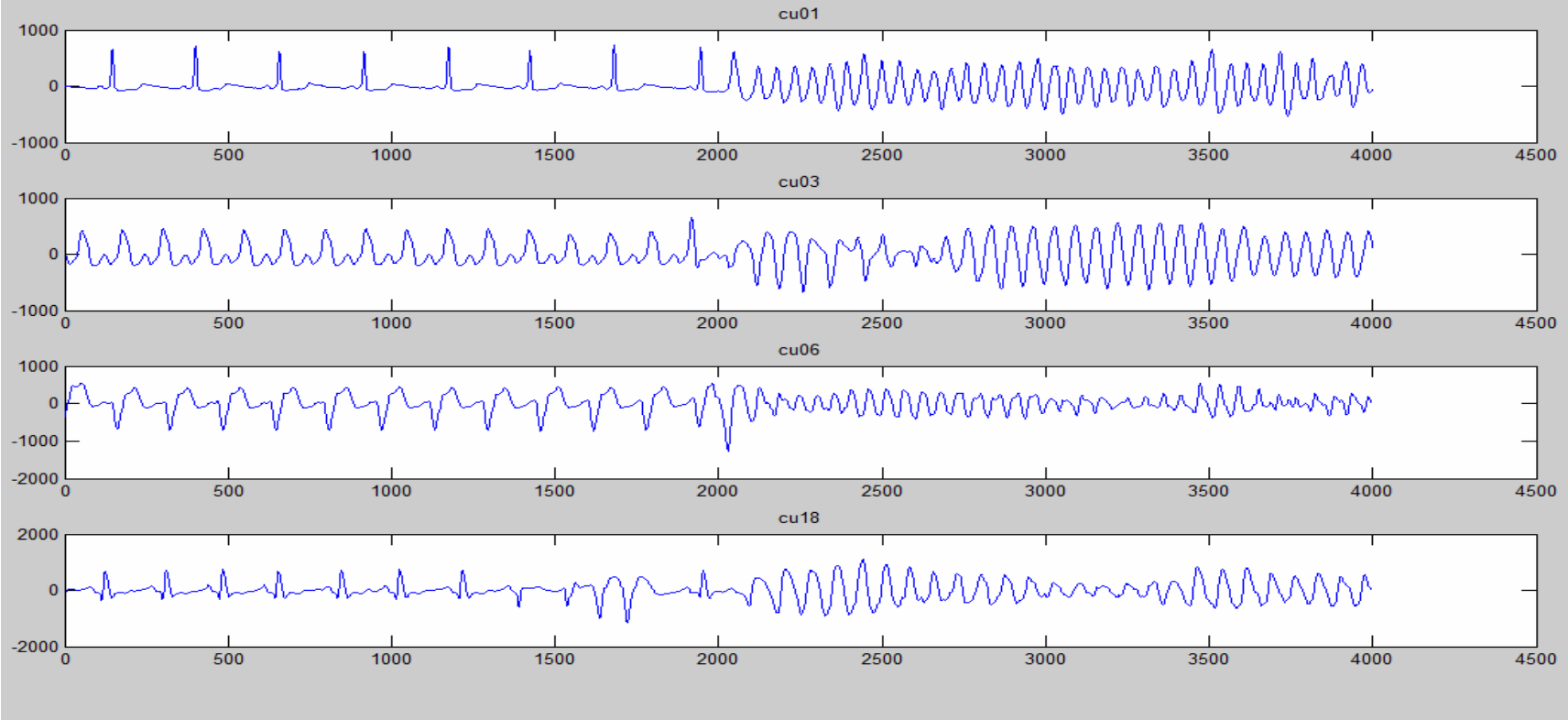
FREQUENCY domain

TIME domain

FREQUENCY domain

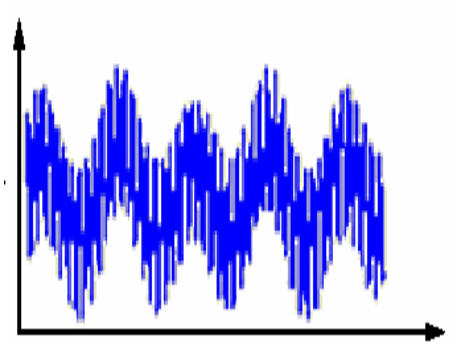
Detecting of Ventricular Fibrillation (VF) in Real Time

WAVES SHAPE MODIFICATION



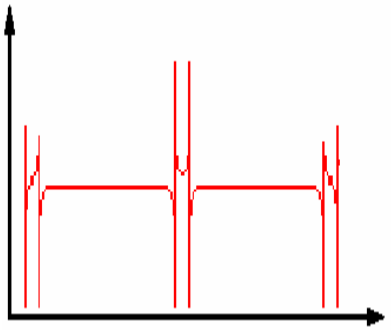
Signal Processing

Def.: A 1D Signal is a sequence of numbers that describes the variation of some variable.

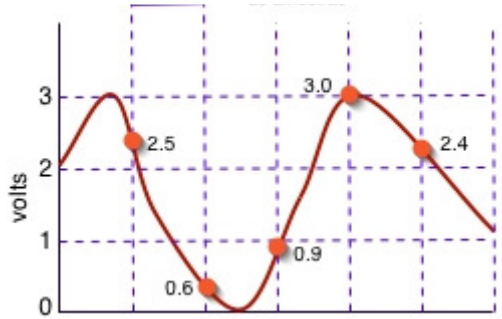


Time

Fourier Transform

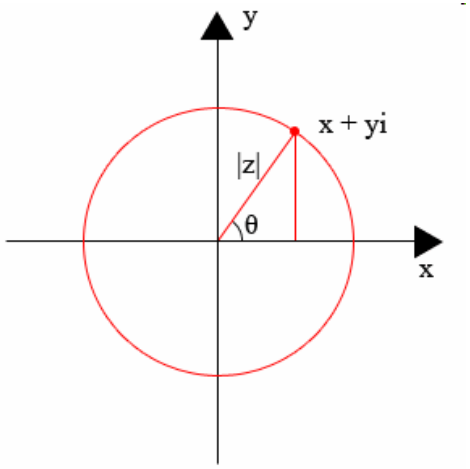


Frequency



The onversion from analog to digital signal is performed by a sequence of samples

Fourier Transform ;
goes from Real number to complex number



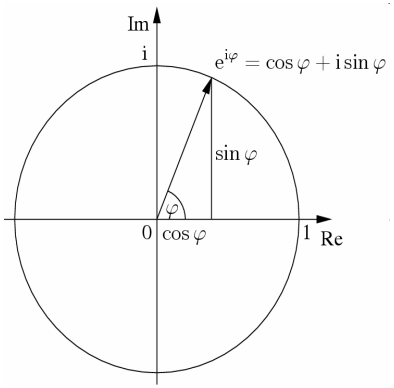
complex *C* represented as : ***a +b i = a +b j***

a e ***b*** are real *parts of the* ***C*** ;
i or ***j*** is ***the*** imaginary

$$j = \sqrt{-1}$$

$$F(u) = \frac{1}{N}\sum_{x=0}^{N-1} f(x)\exp[-j2\pi ux/\mathrm{N}]$$

$$f(x) = \frac{1}{N}\sum_{u=0}^{N-1} F(u)\exp[j2\pi ux/\mathrm{N}]$$



$$e^{ix} = \cos(x) + i\,\mathrm{sen}\,(x)$$

Fourier spectrum, **phase angle and** energy or power **spectrum**:

$$|F(u)| = \left[R^2(u) + I^2(u)\right]^{1/2}$$

$$\phi(u) = \tan^{-1}\left[I(u) / R(u)\right]$$

$$P(u) = R^2(u) + I^2(u)$$

http://lodev.org/cgtutor/fourier.html#dc

bidimensional Fourier Transform (continuous form):

$$F(u,v) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)\exp\left[-j2\pi(ux+vy)\right]dxdy$$

$$f(x,y) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} F(u,v)\exp\left[j2\pi(ux+vy)\right]dudv$$

$$e^{ix} = \cos(x) + i\,\mathrm{sen}(x)$$

$$F(k,l) = \frac{1}{N^2}\sum_{a=0}^{N-1}\sum_{b=0}^{N-1} f(a,b)\, e^{-i2\pi\left(\frac{ka}{N}+\frac{lb}{N}\right)}$$

bidimensional Fourier Transform
(discrete form):

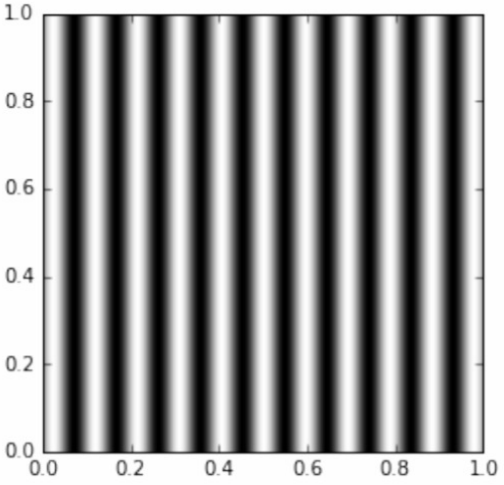
- Transformada de Fourier

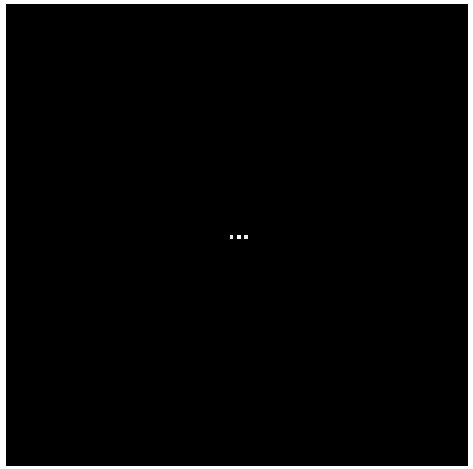
$$F(u,v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) e^{-j2\pi\left(\frac{ux}{M}+\frac{vy}{N}\right)}$$

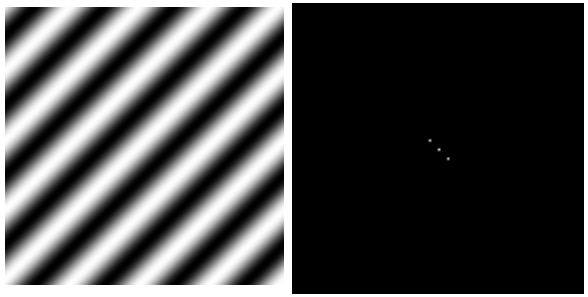
- Transformada Inversa de Fourier

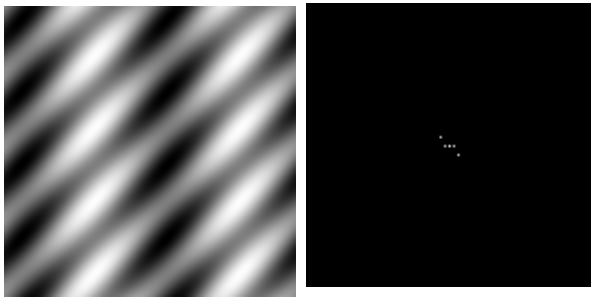
$$f(x,y) = \frac{1}{MN} \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} F(u,v) e^{j2\pi\left(\frac{ux}{M}+\frac{vy}{N}\right)}$$

$$j = \sqrt{-1}$$









Processing : **feature computations or feature extraction from the signal**

Ex. OF feature (características) temporal in a window of size J

Mean absolute value (MAV) normalized $$MAV = \frac{1}{N}\sum_{n=0}^{N-1}|x(n)|$$

The idea of a good size for region of interest - ROI or **window** is very important (dadaset of ECG from **MIT-BIT PhysioBank** of **Physionet, in bitnary** code)

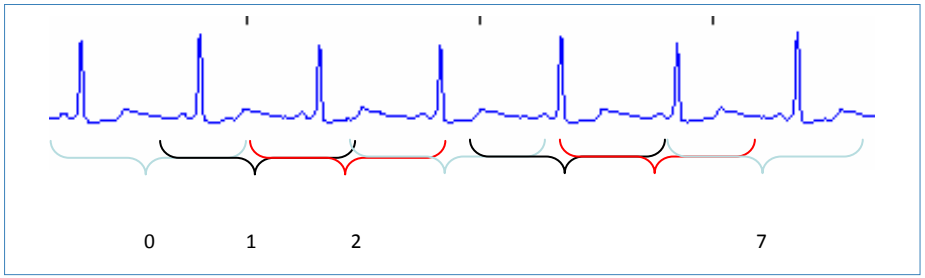
Detecting of Ventricular fibrillation in Real Time

Algoritmo de detecção de VF

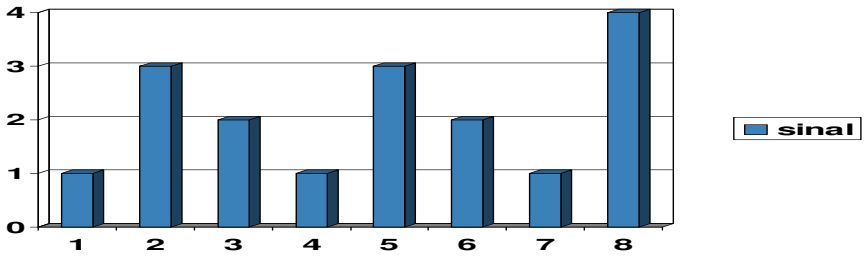
Winfows Size and setp = 2s , distance of 1s

Mean absolute value (MAV) normalizado (Abu, 2010)

Sub-janelas de 2s a distancia de 1s



$$MAV = \frac{1}{N}\sum_{n=0}^{N-1}\left|x(n)\right|$$



Exemplificando:

Se o sinal for definido pela série : x_i *i= 1, 2, 2,....N*
1, 3, 2, 1, 3, 2, 1, 4

Então N=8

A **Mean absolute value (MAV)** será: $x_{i+}\ x_{i-1}$
1+3+2+1+3+2+1+4 = 17

A MAV normalizada será: 17/8 = 2,125

$$MAV = \frac{1}{N}\sum_{n=0}^{N-1}\left|x(n)\right|$$

The **Short Time Average Energy** (STE)

shown in Equation (5),

$$STE = \sum_{m=0}^{M-1} x^2(m) \quad (5)$$

is a simple and vastly used feature for segmentation

the **Low Feature-Value Ratio** (LFVR)

was used to characterize signal and background noises and is given by Equation (7):

$$LFVR = \frac{1}{2N}\sum_{n=0}^{N-1}[\sin(0,5\,avSTE - STE(n) + 1] \quad (7)$$

where *avSTE* is the average *STE* in the total number of frames or waves considered.

The **Root Mean Square** (RMS)

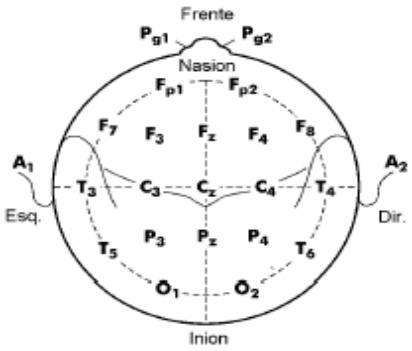
value measures the signal energy and is defined by Equation (4):

$$RMS = \sqrt{\frac{1}{M}\sum_{m=0}^{M-1} x^2(m)} \quad (4)$$

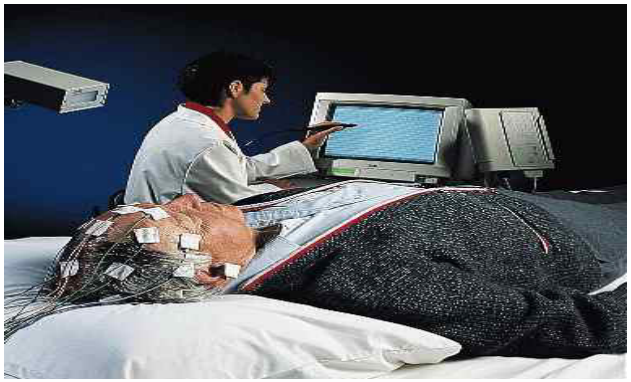
where *M* is the number of samples and *x(m)* is the signal of the sound.

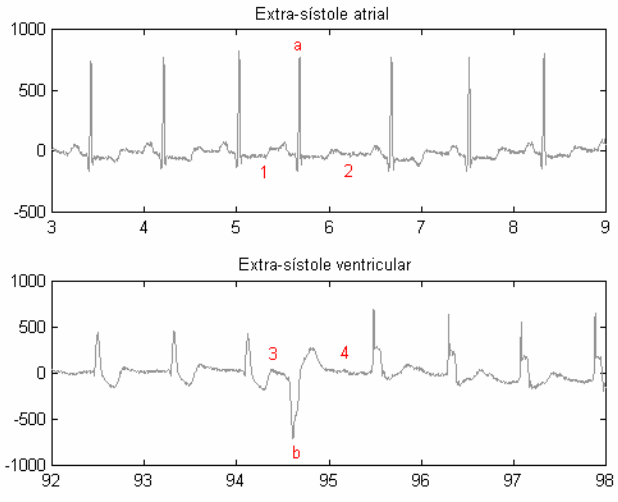
other possible aplications:

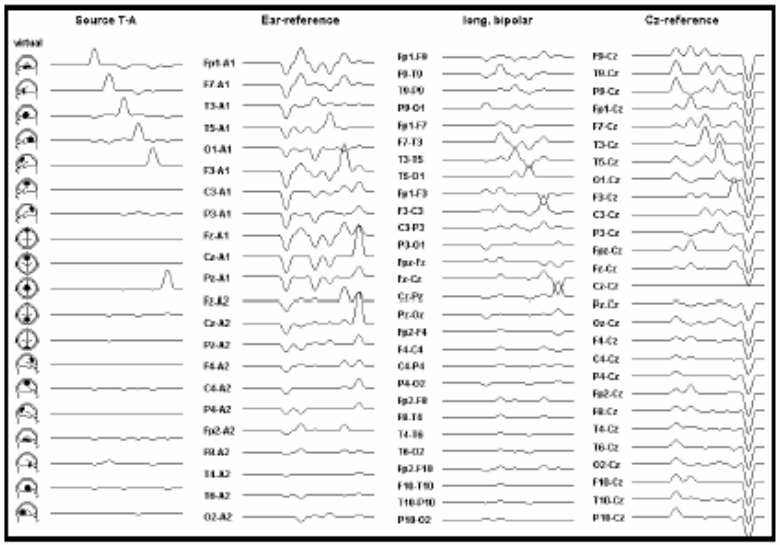
1D – ECG
+- 20 – EEG
nD – térmicos – EMG , etc



Examinations







other possible aplications: seguence of images

e.g. consider this breast research aspects “....
Series of information can be treat as a signal

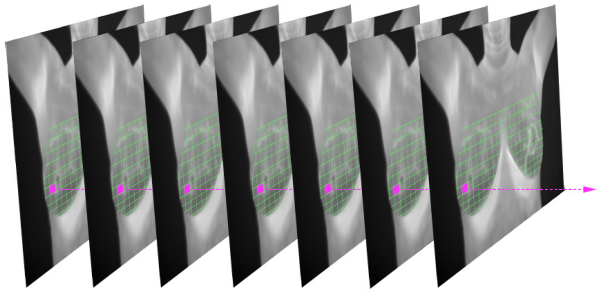


Figure 5: Observing the higher temperature of a breast square region in all thermograms of the sequence to form a time series.

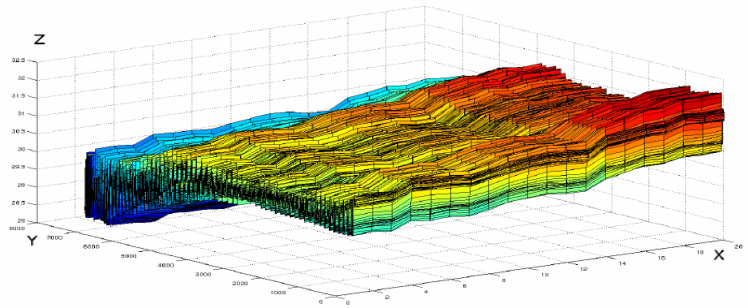


Figure 7: Temperature time series of a healthy patient.

A New Database for Breast Research with Infrared Image
https://doi.org/10.1166/jmihi.2014.1226

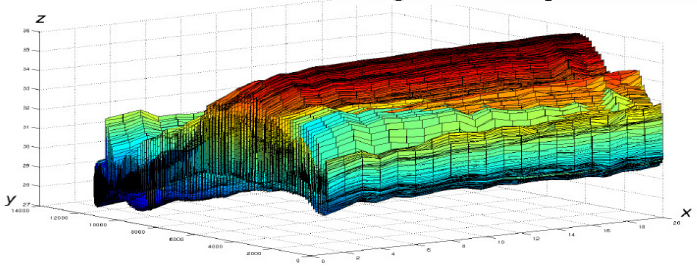
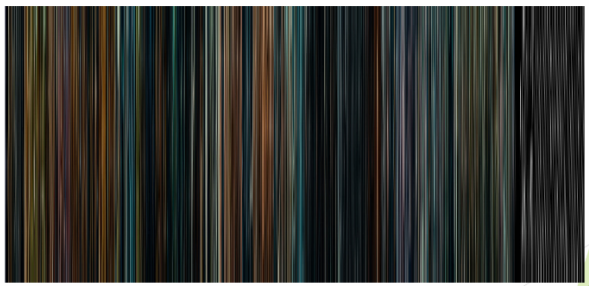


Figure 6: Temperature time series of a patient with cancerous tumors.

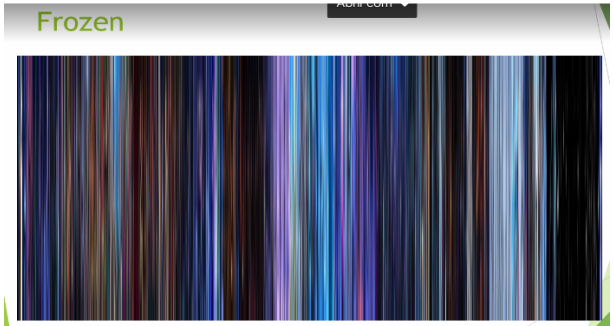
Case 3 – Similar movies

Are the Barcodes good for movie retrieval? Or query?

The Lord of the Rings: The Fellowship of the Ring



Frozen



Ratatouille

TV Series similarity based on “barcode” images

The “barcode” is already a feature, however it looks only represent **the colors of the scene.**

But can be a good initial point to do experiments using diverse frames steps for compute as barcode.

After this computations :

how do you consider to **identify similarity among type of movies?**

Some king of clustering could be used?

Or are you thinking about the use of a supervised learning approach ?

How about after to include feature based in the SHAPE , LIKE THOSE FROM edges of the frames, like the HOG recommended for Augusto?

Case 4 - TEXTURE BASED SURFACE INSPECTIONS

ACQUISITION OF features DIFERENCE FROM rough TEXTURE & SOFT ONE

Because the proposal is already from the initial step to an end, but there are a lot of points do improve in order to do a good research

There are two types of features for identifycation of:

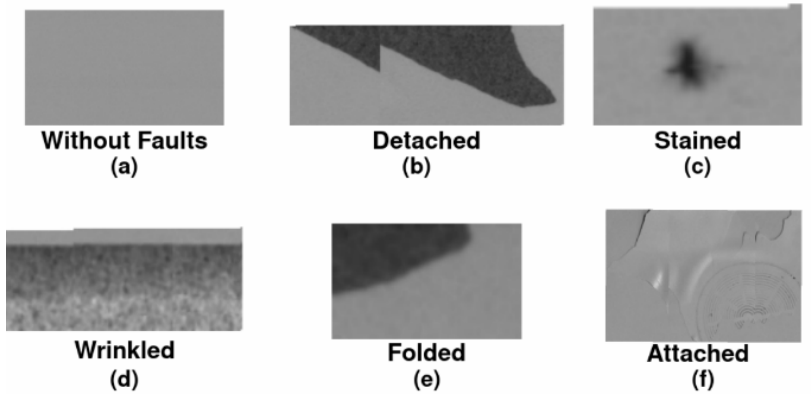
- **Soft texture**

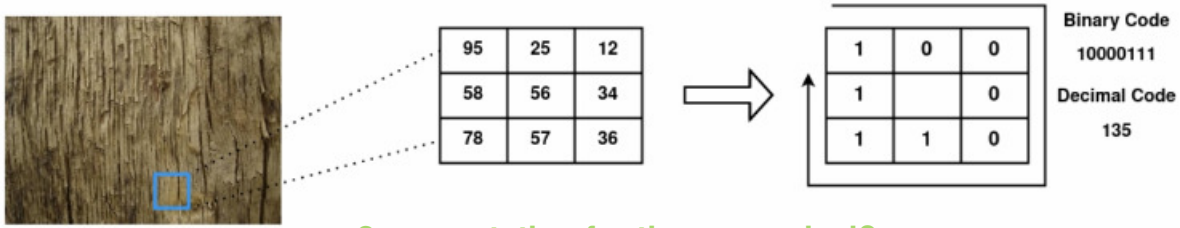
(only histogram of gray level)

- **And real texture : the texel size is a very important aspect not only for the LBP but details of its variations must be well comented.**

“

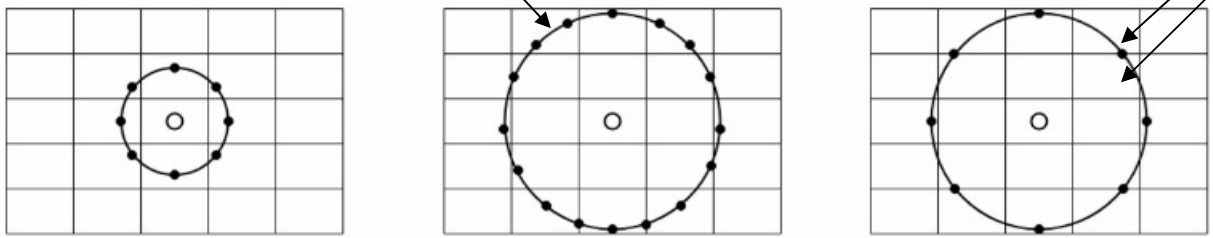
Almost only gray level intensity and no TeXTURE BASED defect on the SURFACE





2 computation for the same pixel?

What is the pixel?



Case 5 -

Analog Dial reading

2 Pointers identification;

The numbers in its neighborhood;

Position in the small circle of the small pointer?

Preprocessing = edge detection, numbers improvements

Circle and number identifications

Tree decision rules for finding the answer : it is what is in the image when reading by human yes ? (the same numbers!)

Case 6 -

Hands Analog motions identifications

Among a number of possible movements?

I am not sure it is it?

In this case this idea can be similar to the Rodrigo ones, of
Hands identification for the alphabet in the Signal Langue

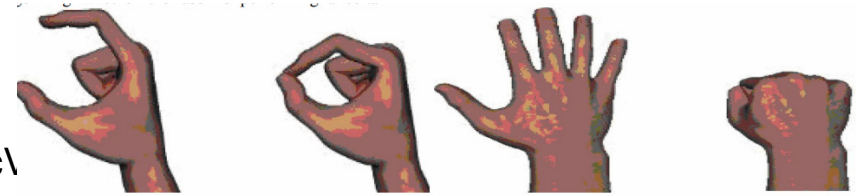
But do not the LIBRA (Brazilian language of signals)

And how about try features without Neural Nets ?

https://youtu.be/3WJPIO2hHhI

Case 7 – Signal language for the alphabet

https://www.youtube.com/playlist?list=PLt-HAUhESHxVvzc\



(A) PINCH OR CHOOSE GESTURE. (B) GRABBING GESTURE.

Fig. 3. *Some gestures available in the tool used for capture hand moves.*

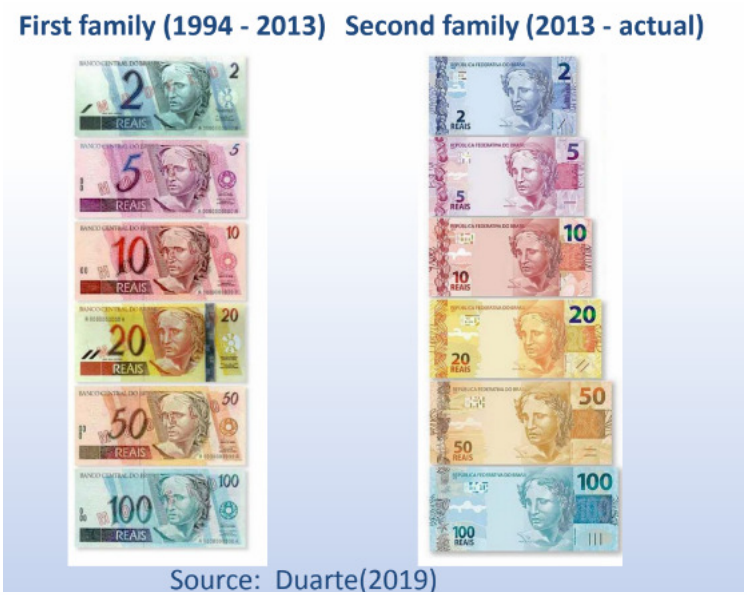
> the Devkit Manomoton, Unity Engine provide a structure for analyzing 3D gestures n real time;

SDK Manomotion ca be used, which categorizes each pose of the user's hand.

These poses are divided into the categories: grab, pinch and point, such categories are classified as different Manoclasses being the most important components for hand position analysis.

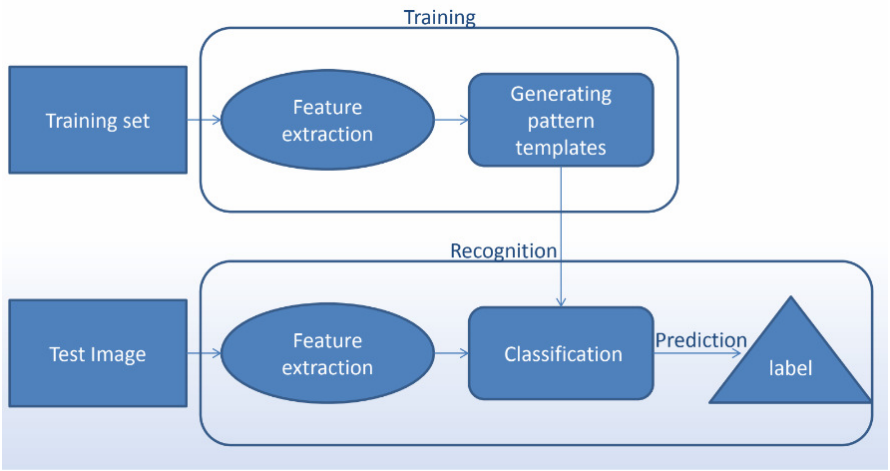
Case 8 – Brazilian money recognition

New features for this good scheme



features using different groups like colors, part of numbers, etc

And a tree decision initially (maybe) …



Thanks!

Any questions?

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