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The Improvement of An Acquirement Time For The Medical Images IRM (Imagerie By Magnetic Resonance)

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Abstract: We present in this article the improvement of an acquirement time for the medical images IRM. This method helps to detect the lesions just as although the physicians in the 87% of the cases. With regard to the dimension of the lesion, the development of the techniques of classification detects the lesions whose minimal dimension is of 10 pixels undoubtedly (10x10). For the lesions of smaller measurements, the results are variable but important progress are now achieved. It can influence the quality of the RMN picture and therefore to lead a diagnostic more reliable of the illness (newborn Tumor, sclerosis in plate, other degenerative lesions) in the case of cerebral pictures in relation to the rays 'x'. to improve the time of acquirement that is function of S/B, we intend to improve the S/B report, while reducing the time of repetitions of the impulses of rephrasing (TR)(echo - spin), TE:S/B= f(TE, TR).The S/B is used to express the relative contributions of the signal and the uncertain signals (noise) to the detected signal. Our goal, in this work is the improvement of the acquirement time, by software of automatic classification, what is going to create distinct zones according to the structure of cloths. These zones would generate some clusters (classes) distinct: All anomaly in this classification can be interpreted as the presence of a pathology(ill) and his/her/its made picture in optimized one time.

Key words: IRM, automatic method, S/B, time of acquirement, density of probability

INTRODUCTION

In 1978, the first clinical pictures were gotten and in 1983 one lives to appear on the market the first facilities of IRM (IRM images)[1-5].

The imagery by magnetic resonance (IRM) contrary to the imagery by X-rays, doesn't have a tradition. The diagnostic with the help of the IRM pictures is very different from the one of the X-rays. An exam by magnetic resonance is long compared to an exam by X scanner, the first requires on average about 30 min, during all this time the patient must remain immobile. The patient's movement results in a deterioration of the quality of the picture and a loss of the resolution. Of or the interest to what the patient is the most relaxed possible when he goes in the image. For this reason, we were interested in the optimization of the time of acquirement of the IRM pictures by the methods of the classifications supervised and non-supervised.

$$\frac{S}{B}=\frac{w.C_{\perp}.M_{xy}.\delta V}{Bruit} \quad (1)$$

where:
w : The angular frequency (throbbing)
δV : The volume of the voxel.
M_{xy} : The transverse component of the aimantation
$C_{\perp}$: The sensitivity

For the patient's comfort, it is necessary limited lasted it of imagery exam to one time reasonably[3,6-10] that improve the S/B report:

$$s_i = f_i \{T_1, T_2, .T_R, T_E, T_I, .\} \quad (2)$$

$$T_{acq} \propto (n \cdot M \cdot (S/B)^2 \cdot C^2 \cdot T_R \quad (3)$$

If the report signal on noise is raised, so, the contrast picture will be able to be more weak, if the contrast picture is raised, so, the S/B report will be able to be weaker by same power of resolution[2,5-9].

THE OPTIMIZATION OF THE SIGNAL

The optimization of the report signal on noise conditions major way the quality of the picture. It understands two stages: The increase of the resonance signal and the reduction of the noise:[2,5-9].
I: represent the intensity of a structure or a lesion.

$$P \propto (S/B)^2 \cdot C^2$$

$$\Rightarrow (S/B) \propto \frac{\sqrt{P}}{C}$$

$$T_{acq} \propto (n \cdot M \cdot (S/B)^2 \cdot C^2 \cdot T_R$$

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The power of resolution increases with the S/B report and the contrast picture by the following relation:[2,3,5-9]

$$P \propto (S/B)^2 \cdot C^2 \quad (4)$$

and

$$C=(I-I_0)/I_0 \quad (5)$$

The intensity of the signal follows the following relation:

$$I=\rho\cdot(1-e^{(-T_R/T_1)}) \quad (6)$$

$$I\approx\rho\cdot(1-e^{(-T_R/T_1)})\cdot e^{(-T_E/2)} \quad (7)$$

Where

ρ: Is the density of proton.

The relation between contrast picture, contrast object and spatial resolution is:[2,3,5-9].

$$C=C_{obj}\cdot\exp[-(d/D)^2] \quad (8)$$

Where:

p: spatial resolution
n: represent the number of accumulations (repetitions).
M: is the division of the field explored.
T_R: is the time of repetition of the sequence.
C: represent the contrast picture.
I_O: the intensity of the neighboring region.
C_{obj}: the contrast object(depend of the density of protons, of the parameters of relaxation(T1, T2), programmable factors or sequential (parameters): (T_E, T_R, M, P..).
d: is the width to mid height of the function of modulation transfer that one will suppose Gaussien type.
D: the diameter of the lesion or the structure that detaches itself of the context. In fact a third variable comes to impose itself to us in the expression of the resolution power: it is the time of acquirement and the time of exam.

For an imagery of (2DFT) the time of acquirement writes itself:[2,7-9].

$$T_{acq}=n\cdot M\cdot T_R \quad (9)$$

Fig. 1: The sequence of spin echo is defined by two parameters of sequence: TR that separates two excitations to 90° successive and the time of echo(TE) that separates the excitation of the measure's echo.[2,7,9]

In which:

n: represents the number of accumulations (repetitions).
M: is the division of the field explored (in the direction of the gradient of diphase).
TR: is the time of repetition of the sequence.

For the imagery to three measurements (3DFT) the time of acquirement writes itself:[2,7-9].

$$T_{acq}=n\cdot M\cdot P\cdot T_R \quad (10)$$

P: is the number of projections in the three directions.

In the optimization of the acquirement protocols, it is necessary to take into account the variation of the parameters texture or intrinsic (T_1, T_2), what brings us to a statistical survey of this variability, while using the techniques of classifications and the densities of probability[2-4,7,9-12].

THE METHOD OF THE BASIS SEQUENCES

To get a picture, this one was gotten while always repeating the same operation, but while making vary the amplitude of the phase gradient in order to localize the signal and commits one acts on this procedure to get the pictures whose contrast depends on the density of protons, of the relaxation time longitudinal T1 and of the relaxation time transverse T2.

Let's start with defining the three times of basis that intervene the most often in the sequences used in IRM. Fig. (1).

- The time of repetition (T_R): it is the one - that separates the beginning of a sequence of the beginning of the following sequence.
- The time of inversion (T_I): it is the interval of time between the impulses 90°et 180°.

Table 1 The level-headedness in T1, T2 by report TE and TR.[2,9]

	T_E	T_R
Wheited in T_1	Short<=30	Short<=600*
Wheited in T_2	Long T_E>=80	Long T_R>=2000

The time of echo of spin (T_E): it is the interval of time that separates the impulse to 90° his/her/its echo, after application of an impulse of re focusing to 180°[2,6,7,9].

Notes:
L.C.R: liquid Cephalo - Rachidian
s.white. half note: white substance
s.grise. makes gray: gray substance.

-The amplitude of the signals varies in the inverse sense of the one of the T1 of these cloths,

-The contrast in T1 is especially strong than the TR is short, but on the other hand the S/B report is especially weak than TR is short. The choice of a TR neighboring of the times of T1 relaxation of cloths, constitute a good compromise between contrast and S/B.

-The amplitude of the signals varies this time in the same sense the one of the T2 of these cloths making that the contrast in T2 is especially strong that the time of echo is long but that then the S/B is of as much weaker. The choice of one time of echo that corresponds twice to the value of the T2 constitutes a good compromise[2].

The choice in TR determines the contrast in T1 of application on the sequence of repetition time (TR) and of Time of Echo(TE).

The Table 1 according to, control the level-headedness in T1, T2 by report the time of echo and the time of repetition.

T_R: controls the quantity of transverse aimantation that covers the longitudinal plan.

In a picture pondered in T_1, a short T_R is defined to produce the effects of saturation. More T_R are short, more the effects of saturation (T_1) are visible in the contrast.

In a picture pondered in T_2, a long T_R is defined to minimize the effects of saturation. Of other effects as the diphase (T_2) can predominate on the contrast of the image[2,9].

Where
NA: non active
Nb: number
PD or ρ : density of proton

For the optimization of the acquirement protocols it is necessary to take account of this variability observed of the textures parameters. The mathematical support of this variability of the textures parameters is the function density of probability. At the time of the IRM exam, the function of density of signal probability is the size accessible to the measure, whose general expression writes it self:

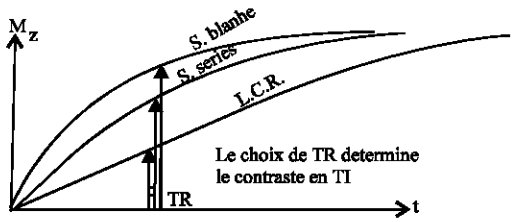

Fig. 2: Level-headedness in T_1 of the contrast for different cerebral cloths: white substance, gray substance and L.C.R.[2]

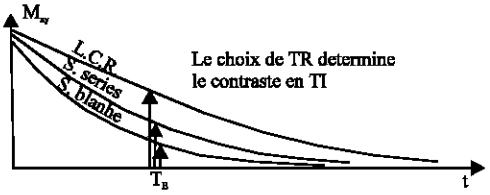

Fig .3: Level-headedness in T2 of the contrast for different cerebral cloths: white substance, gray substance and L.C.R.[2]

$$s_i = f_i \{T_1, T_2, .. T_R, T_E, T_I, ..\} \quad (11)$$

i=1, 2,. n: Represent the order of the sequence
f_i: Represent the shape forms it of the function for each of the n sequences
T_1,T_2,: represent the textures parameters .

	T_1	PD	T_2	numbers of	time of acquireme	S/B (SNR)	Resolution	Artefact of flux	Magnetic T_2
If T_2	←	→	→	→	→		NA	→	NA

T_E,T_R, T_I,: Represent the sequential parameters.
It means that:

The optimization of the imagery protocol between textures will consist in determining the sequential parameters, as the recovery of the beaches of signals is minimal. For this reason based some on calculates it of the probability density between textures according to the average and the variance, where has apply some of the methods of classification that one can see it below.

EXPERIMENTAL RESULTS ON THE CLASSIFICATION OF THE IRM PICTURES

Method of doorstep: It is a geometric, simple method but less robust simple but less robust than the statistical methods;

Method of the classification supervised: It is a statistical method, every class represents a rectangle characterized by two parameters: the average and the variance. Then one calculates for every pixel(observation) of the picture the values of the discriminative functions and to choose the maximum:[2,5,7,10,13].

$$d_t(v)=\ln p(v/t_t)+\ln P_{t_t}\ (t=1,2,....,T) \qquad (12)$$

One supposed (probability a priori) is constant.
$P(v/t_t)$: is the function of probability density

The algorithm:
To load the picture to treat.
To give the number of classes.
To display the picture to treat.
To select from the screen the rectangles of the practice regions.
To sweep all pixels of the picture while affecting them at the region presenting the biggest discriminative function.
To give a color in every constructed region.
To display the thematic picture.

The histogram of the thematic picture: After selected the regions of the classes one has verify p(n) of every region, from used the value of the verisimilitude maximum in the case of gauss[2,4,5,7,10,13]. Because it starts from a pixel representing a whole region

The algorithm:
To load the picture to treat.
To give the doorstep of tolerance.
To display the picture to treat.
To select from the screen the representative pixels.
To sweep all pixels of the picture while affecting them to the nearest pixels of point
of gray view level.
To display the thematic picture.

$$p(v/tt)=\frac{\exp[-\frac{1}{2}(v-\mu_{t_t})^{t'}\sum_{t_t}^{-1}(v-\mu_{t_t})]}{(2\pi)^{c/2}\left|\sum_{t_t}\right|^{1/2}} \qquad (13)$$

$$p(v)=\sum_{t=1}^{T}p(v/t_t)P_{t_t} \qquad (14)$$

where

P(v): is the function of density of probability of the mixture, weighted of the functions of density of the T classes.
$P(v/t_t)$: Represents the function of probability density under ownerless to the distribution of the observations coming from the class tissue t_t.
μ_{tt}: is the middle vector of the distribution to composing c.
$\sum_{tt}$: is the matrix of covariance C x C of the determinant distribution= $|\sum|_{tt}$
v: is the variance squared of the s gap that is the hope of $(v-\mu)^2$.

To estimate the maximum of verisimilitudes of the average and the matrix of covariance one finds:[2,4,5,7,10,13].

$$\mu_e=\frac{1}{r}\sum_{K=1}^{r}v_k \qquad (15)$$

$$\sum_e=\frac{1}{r}\sum_{k=1}^{r}(v_k-\mu_e)(v_k-\mu_e)^{t'} \qquad (16)$$

$$\sigma_e^{\ 2}=\frac{1}{r}\sum_{k=1}^{r}(v_k-\mu_e)^2 \qquad (17)$$

where
To load the picture to treat;
To give the number of regions to analyze;
To display the picture to treat;
To select from the screen the rectangles of the practice regions;
To construct the histogram for every oblong region;
To display the different histograms verifying that the probabilities are well for gauss

Method non-supervised: The shape of p(v) is known, he/it remains to determine the average and the matrix of covariance, one it is based on the contours of the probability density under - ownerless, as constructing a mathematical model, the resolution of this model, give us the middle vector and the matrix of covariance directly. The easier method to implant on the micro is the method of the cores, the well-stocked results depend on the size of the cores, it is for this reason that we considered the size as being the surface of this core. The used formula is the following:[2,5,10,13].

$$P(\upsilon/\upsilon\in D)=\frac{\frac{k}{r}}{V(D)} \qquad (18)$$

Where
k: is the number of observations (pixels) that are situated

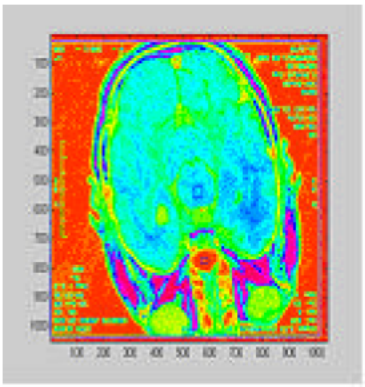

Fig. 4a: Thématic image

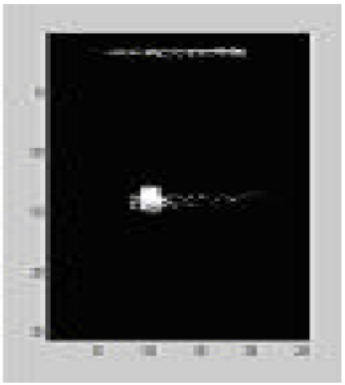

Fig. 4.b: L 'assembly of the two rectangles turns into pixels

Fig. 4: Execution of the class no supervises where : N°=2, seuil of center gate(barycenter)=10 half large odd of stone

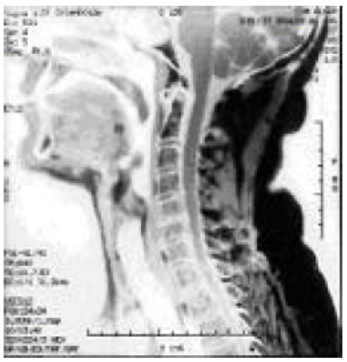

Fig. 5a: Original image

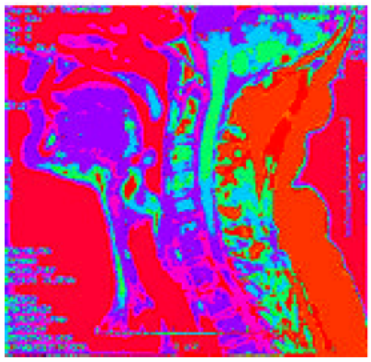

Fig. 5b: Thematic image

Fig.5Method of doorstep where number of class=8, tolerance=10 (the time = 4min).

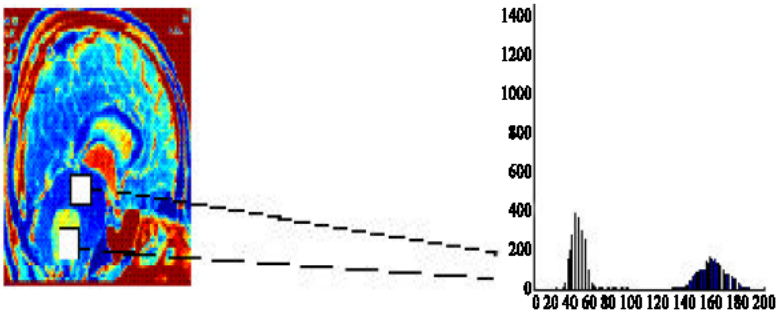

Fig. 6a: Original picture with the selected regions

Fig. 6b: Histograms of density p(v)of selected two regions

Fig. 6: The method of histograms

in the D domain;
r: is the total number of observations in the space of the pixels,;
V (D): is the volume of the core, in the case,

The algorithm:
To load the two IRM pictures;
To filter the two pictures with the filter of Wiener
To fix the size of the square core;

To estimate p(n): underlying probability density;
To extract the contours of p(n) with contours3 while using Matlab5.2.
To calculate the center of every contour;
To construct a mathematical model with the points of the different concentric contours;
Evaluation of de μ and $\sum$.
To calculate the discriminative functions corresponding to every pixel;
The pixel will be affected to the region presenting the biggest discriminative function.
or C = 2, V(D) is the surface of the core.
One didn't use the method of convexity since it is difficult to approach two stones by ellipsis that served to extract the parameters: μ and Σ of every region.

COMPARISON BETWEEN THE SUPERVISED METHODS, NON SUPERVISED AND THE DIAGNOSTIC OF PHYSICIAN

The extension of the lesion and the cutoff of the borders between the pathological cloth and the healthy texture has been appreciated better than the physician respectively by The methods of the comparable to those of the physicians in 50 and 44% of the cases[2,7,14].

RESULTS

Example on the non supervised method: In Fig. 4 we have the Execution of the Class no supervises where : N°=2, seuil of center gate(barycenter)=10 half large odd of stone size

Example on the method of doorstep: For second example we have done the execution of the Class no supervises with:
N°=2,seuil of center gate(barycenter)=10 half large odd of stone size. Fig. 5.

Example on the histogram: The third example is the histograms of density for two region selected. (Fig. 6)

CONCLUSION

A few years ago, the IRM was known like an essentially morphological imagery technique, with clinical Indications, limited mainly to the pathology of the central nervous system.

The development of the different techniques of imagery stand art:

Semi-rapids, fast and ultra - rapids and their future impact on the cost of the IRM in clinical routine marked in a remarkable way the diagnostic medical. However, subject to a sufficient reduction of the price of the exam and because of his/her/its character" no - invasive", the IRM could become one day one of the first modes of tracking of minute lesions[5-7].

THE PERSPECTIVES

With the development of techniques die-hard rapids of acquirement and treatment of data, he/it became possible to achieve some RMN pictures in sufficiently brief times (until 0.02 second) to follow some aspects of the metabolism. One speaks then of IRM functional (IRMf)[15,16].

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