Ischemic stroke detection through image processing techniques

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Introduction

• Stroke is considered a non-transmissible chronic disease;

• It is estimated that in 2016 there will be 18 million new cases worldwide;

• In Brazil, stroke causes the death of approximately 100,000 people each year.

National Institute of Aging, Publication no. 07 (2007)
Garritano et al. (2012)
Stroke Classification

- **Ischemic (87%)**: obstruction of vessels that supply blood to the brain;

- **Hemorrhagic (13%)**: disruption of a blood vessel and spread to brain tissues.

  - Even when not cause deaths, stroke can cause damage that compromise life quality;

*Roger et al. (2012)*
Detection
Primarily diagnosed clinically and confirmed and followed through imaging tests.

- Cerebral Angiography
- CT scan: w/ or w/o contrast
- MRI: w/ or w/o contrast
  - T1 or T2 weighted (T1WI, T2WI)
  - FLAIR
  - Diffusion weighted image (DWI)

Amar (2011)
Introduction

- **MRI advantages:**
  - excellent detection of ischemic tissues;
  - does not use ionizing radiation;
  - more imaging sequences;

- **CT advantages:**
  - more accessible examination;
  - faster than MRI;
  - preferably used for emergency decisions.

*Amar (2011)*
Stroke Diagnosed with CT

• Distinguish between ischemic and hemorrhagic stroke.
• Ischemic stroke with hemorrhagic transformation >> the wrong choice of treatment can lead to patient death;

Hyperdense area of hemorrhage

Chawla et al. (2009)
Treatment

- *Tissue Plasminogen Activator (rt-PA)* is a protein involved in the breakdown of blood clots and is used to treat embolic or thrombotic stroke.

- There is an effective treatment window of 3 hours.

*Stroke Guideline (2013)*
ASPECTS - *Alberta Stroke program early CT score*

- Standard ischemic stroke diagnosis with a reproducible scoring system;

- The score divides the middle cerebral artery (MCA) territory into 10 regions of interest.

- A single point is subtracted for an area of early ischemic change, such as focal swelling or parenchymal hypoattenuation, for each of the defined regions.  

  *Pexman et al. (2001)*
This analysis is thus a subjective estimative of the affected area by ischemic stroke.

Pexman et al. (2001)
Objectives

• Quantify and enhance brain areas of interest (normal brain, ischemic stroke) through automatized computational algorithms;

• Comparison the detection of ischemic stroke between the computational algorithm and neuroradiologists.
Methods

• Construction of a database with retrospective examination of patients diagnosed with stroke;

• **Inclusion criteria**
  • patient diagnosed with stroke by specialist (neuroradiologist);
  • CT scans acquired with at least 16 slices scanner;

• **Exclusion criteria**
  • history of intracranial hemorrhage;
  • Malformations, tumors and aneurysms.
Methods

Computational algorithm was developed in Matlab software

1. Initial Image
2. Image segmentation
3. Multiscale enhancement (wavelets)
4. Fuzzy C-means clustering
5. Final Image
6. Area Quantification
7. Active Contour
Methods

Stage 1

• Subjective analyzes were performed by neuroradiologists to quantified ischemic areas in the middle cerebral artery region.

• They performed an manual segmentation process within the ischemic stroke region.
Stage 2

Application of the computational algorithm on the same CT scan slices.

Comparison of both results.
Examples of images evaluated
Methods

Examples of images evaluated
Results

• Multiresolution analysis via Wavelets: enables the segmentation of an image by highlighting morphological characteristics and frequencies.
• Fuzzy c-means clustering (FCM): identified natural groups in a wide range of data.
• 15 patients were analyzed;

• Neuroradiologists found that the morphological filters actually improved the ischemic areas;

• The comparison in area between the neuroradiologist and the computational algorithm showed no deviations greater than 16% in any exams. (underestimate the regions)
Results

Further Analysis

• Sensibility

• Especificity

• Jaccard index

• Dice coefficient
Contributions of this work

• Applying a set of image processing tools for CT scans;

• The algorithm could assist the performance of neuroradiologist for assessment of stroke;

• Development of a computer aided diagnosis software.
Contributions of this work

In clinical practice:

Aid for the inexperienced or non-specialist radiologists;
Greater efficiency in the diagnosis;
Early diagnosis (within 3 hours of treatment window);
References


Thank You!