**Classification of Brain Haemorrhages in Head CT Scans**

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Declaration

# Abstract

# Acknowledgements

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# Introduction

* General introduction to topic assuming reader has 0 background
* Aims and goals
* Approach
* Assumptions
* High level description
* structure

# Background and literature review

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## Medical Aspect

## Clinical definition and types of Brain Haemorrhage

## Computed Tomography

## How CT works

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## Image segmentation, thresholding and pre-processing of images

## Technological Aspect

## Machine Learning

## Classification

## Classification in Computer Aided Diagnosis

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## Criticism of current techniques

## Proposed system

# Specification and design

# Implementation

# Testing and/or evaluation

# Results and discussion

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# Works Cited

|  |  |
| --- | --- |
| [1] | B. Pourghassem and H. Shahangian, “Automatic brain hemorrhage segmentation and classification in CT scan images,” in *8th Iranian Conference on Machine Vision and Image Processing (MVIP)*, Zanjan, 2013. |
| [2] | A. M. Naidech, “Intracranial Hemorrhage,” *American Journal of Respiratory and Critical Care Medicine,* vol. 184, no. 9, pp. 998-1006, 2011. |
| [3] | B. Sharma and K. Venugopalan, “Classification of hematomas in brain CT images using neural network,” *International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT),* pp. 41-46, 2014. |
| [4] | P. Armstrong, Diagnostic imaging, 6th edition ed., Blackwell, 2009. |
| [5] | F. Gaillard, “Subdural haemorrhage | Radiology Reference Article | Radiopaedia.org,” radiopedia.org, 2018. [Online]. Available: https://radiopaedia.org/articles/subdural-haemorrhage. |
| [6] | F. Galliard, “Extradural haemorrhage | Radiology Reference Article | Radiopaedia.org,” Radiopaedia.org, 2018. [Online]. Available: https://radiopaedia.org/articles/extradural-haemorrhage. [Accessed 24 02 2018]. |
| [7] | K. Doi, “Computer-aided diagnosis in medical imaging: Historical review, current status and future potential,” *Computerized Medical Imaging and Graphics,* vol. 31, no. 4-5, pp. 198-211, 2007. |
| [8] | M. P. P. a. S. Choomchuay, “A computer aided diagnosis system for detection of lung nodules from series of CT slices,” in *14th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)*, Phuket, 2017. |
| [9] | F. B. S. A. F. a. M. B. A. K. AlZubaidi, “Computer aided diagnosis in digital pathology application: Review and perspective approach in lung cancer classification,” in *2017 Annual Conference on New Trends in Information & Communications Technology Applications (NTICT)*, Baghdad, 2017. |
| [10] | R. V. M. a. I. C. P. Raha, “Fully automated computer aided diagnosis system for classification of breast mass from ultrasound images,” in *2017 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)*, Chennai, India, 2017. |
| [11] | F. M. B. D. a. S. R. V. Kumar, “A hybrid computer-aided diagnosis system for abnormality detection in mammograms,” in *2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, Bangalore, 2017. |
| [12] | W. |. W. H. Organization, “Who.int,” WHO | World Health Organization, [Online]. Available: http://www.who.int/diagnostic\_imaging/imaging\_modalities/dim\_plain-radiography/en/. [Accessed 28 02 2018]. |
| [13] | “Computed Tomography (CT),” National Institute of Biomedical Imaging and Bioengineering, undated. [Online]. Available: https://www.nibib.nih.gov/science-education/science-topics/computed-tomography-ct. [Accessed 28 02 2018]. |
| [14] | M. Nadrljanski, “Attenuation coefficient | Radiology Reference Article | Radiopaedia.org,” Radiopaedia.org, [Online]. Available: https://radiopaedia.org/articles/attenuation-coefficient. [Accessed 28 02 2018]. |
| [15] | M. Nadrljanski, “Computed tomography | Radiology Reference Article | Radiopaedia.org,” Radiopaedia.org, undated. [Online]. Available: https://radiopaedia.org/articles/computed-tomography. [Accessed 28 02 2018]. |
| [16] | P. Sprawls, “CT Image Quality and Dose Management,” [Online]. Available: http://www.sprawls.org/resources/CTIQDM/. [Accessed 28 02 2018]. |
| [17] | “Education. Whats an MRI,” Multiple-sclerosis-research.blogspot.com, 10 01 2015. [Online]. Available: http://multiple-sclerosis-research.blogspot.com/2015/01/education-whats-mri.html. [Accessed 28 02 2018]. |
| [18] | “Acute CT Brain - Mass effect,” Radiologymasterclass.co.uk, [Online]. Available: https://www.radiologymasterclass.co.uk/tutorials/ct/ct\_acute\_brain/ct\_brain\_mass\_effect. [Accessed 28 02 2018]. |
| [19] | F. Gaillard, “Intracranial haemorrhage | Radiology Reference Article | Radiopaedia.org,” Radiopaedia.org, [Online]. Available: https://radiopaedia.org/articles/intracranial-haemorrhage. [Accessed 28 02 2018]. |
| [20] | “Spontaneous Intracerebral Hemorrhage,” Clinical Gate, 03 12 2015. [Online]. Available: https://clinicalgate.com/spontaneous-intracerebral-hemorrhage/. [Accessed 28 02 2018]. |
| [21] | “Computed tomography,” TheFreeDictionary.com, [Online]. Available: https://medical-dictionary.thefreedictionary.com/Computed+tomography. [Accessed 28 02 2018]. |
| [22] | “What is Machine Learning? A definition - Expert System,” Expertsystem.com, [Online]. Available: http://www.expertsystem.com/machine-learning-definition/. [Accessed 28 02 2018]. |
| [23] | J. Brownlee, “Supervised and Unsupervised Machine Learning Algorithms - Machine Learning Mastery,” Machine Learning Mastery, [Online]. Available: https://machinelearningmastery.com/supervised-and-unsupervised-machine-learning-algorithms/. [Accessed 28 02 2018]. |
| [24] | N. T. N. U. Department of Computer Science and Information Engineering, “Classifier Training and Evaluation,” Department of Computer Science and Information Engineering, National Taiwan Normal University, Taiwan. |

# appendices