# Development of Ground Truth Data for Automatic Lumbar Spine MRI Image Segmentation

By: Natalia, F (Natalia, Friska)[1]; Meidia, H (Meidia, Hira)[2]; Afriliana, N (Afriliana, Nunik)[3]; Al-Kafri, AS (Al-Kafri, Ala S.)[4]; Sudirman, S (Sudirman, Sud)[4]; Simpson, A (Simpson, Andrew)[4]; Sophian, A (Sophian, Ali)[5]; Al-Jumaily, M (Al-Jumaily, Mohammed)[6]; Al-Rashdan, W (Al-Rashdan, Wasfi)[7]; Bashtawi, M (Bashtawi, Mohammad)[7]

IEEE 20TH INTERNATIONAL CONFERENCE ON HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS / IEEE 16TH INTERNATIONAL CONFERENCE ON SMART CITY / IEEE 4TH INTERNATIONAL CONFERENCE ON DATA SCIENCE AND SYSTEMS (HPCC/SMARTCITY/DSS)
**Book Group Author(s):** IEEE
**Pages:** 1449-1454
**DOI:** 10.1109/HPCC/SmartCity/DSS.2018.00239
**Published:** 2018
**Document Type:** Proceedings Paper

## Conference

**Conference:** 20th IEEE International Conference on High Performance Computing and Communications (HPCC) / 16th IEEE International Conference on Smart City (SmartCity) / 4th IEEE International Conference on Data Science and Systems (DSS)
**Location:** Exeter, ENGLAND
**Date:** JUN 28-30, 2018
**Sponsor(s):** IEEE; IEEE Comp Soc; IEEE Tech Comm Scalable Comp; Univ Exeter

## Abstract

Artificial Intelligence through supervised machine learning remains an attractive and popular research area in medical image processing. The objective of such research is often tied to the development of an intelligent computer aided diagnostic system whose aim is to assist physicians in their task of diagnosing diseases. The quality of the resulting system depends largely on the availability of good data for the machine learning algorithm to train on. Training data of a supervised learning process needs to include ground truth, i.e., data that have been correctly annotated by experts. Due to the complex nature of most medical images, human error, experience, and perception play a strong role in the quality of the ground truth. In this paper, we present the results of annotating lumbar spine Magnetic Resonance Imaging images for automatic image segmentation and propose confidence and consistency metrics to measure the quality and variability of the resulting ground truth data, respectively.

## Keywords

**Author Keywords:** Ground Truth; Confidence Metric; Consistency Metric; Lumbar Spine MRI; Image Segmentation
**KeyWords Plus:** BACK-PAIN; DIAGNOSIS

## Author Information

**Reprint Address:** Natalia, F (reprint author)

Univ Multimedia Nusantara, Dept Informat Syst, Tangerang, Indonesia.

**Addresses:**

[1] Univ Multimedia Nusantara, Dept Informat Syst, Tangerang, Indonesia

[2] Univ Multimedia Nusantara, Dept Elect Engn, Tangerang, Indonesia

[3] Univ Multimedia Nusantara, Dept Informat, Tangerang, Indonesia

[4] Liverpool John Moores Univ, Dept Comp Sci, Liverpool L3 3AF, Merseyside, England

[5] Int Islamic Univ, Kuala Lumpur, Malaysia

[6] Dubai Healthcare City, Dr Sulaiman Al Habib Hosp, Dubai, U Arab Emirates

[7] Irbid Special Hosp, Irbid, Jordan

**E-mail Addresses:** friska.natalia@umn.ac.id; hira.meidia@umn.ac.id; nunik@umn.ac.id; a.s.alkafri@2015.ljmu.ac.uk; s.sudirman@ljmu.ac.uk; a.simpson@ljmu.ac.uk; ali_sophian@iium.edu.my; maljumaily@yahoo.fr; drwasfi1@hotmail.com; mohdbakhiet@yahoo.com

## Funding

| Funding Agency | Grant Number |
| --- | --- |
| PKLN funding from Indonesian Ministry of Research, Technology and Higher Education | |

View funding text

## Publisher

IEEE, 345 E 47TH ST, NEW YORK, NY 10017 USA

## Categories / Classification

**Research Areas:** Computer Science

**Web of Science Categories:** Computer Science, Artificial Intelligence; Computer Science, Information Systems; Computer Science, Theory & Methods


**See more data fields**



## Cited References: 14

**Showing 14 of 14** **View All in Cited References page** *(from Web of Science Core Collection)*


1. **Segmentation of Lumbar Spine MRI Images for Stenosis Detection using Patch-based Pixel Classification Neural Network** — **Times Cited: 1**
   By: Al Kafri, Ala S.; Sudirman, Sud; Hussain, Abir J.; et al.
   2018 IEEE CONGRESS ON EVOLUTIONARY COMPUTATION (CEC) Book Series: IEEE Congress on Evolutionary Computation Pages: 538-545 Published: 2018

2. **A Framework on a Computer Assisted and Systematic Methodology for Detection of Chronic Lower Back Pain Using Artificial Intelligence and Computer Graphics Technologies** — **Times Cited: 7**
   By: Al Kafri, Ala S.; Sudirman, Sud; Hussain, Abir J.; et al.
   INTELLIGENT COMPUTING THEORIES AND APPLICATION, ICIC 2016, PT I Book Series: Lecture Notes in Computer Science Volume: 9771 Pages: 843-854 Published: 2016

3. **SpineWeb: Collaborative Platform for Research on Spine Imaging and Image Analysis** — **Times Cited: 1**
   By: [Anonymous].
   SPINEWEB COLLABORATI Published: 2016
   Online Available Accessed: 27-Apr- 2018
   URL: http://spineweb.digitalimaginggroup.ca/

4. Title: [not available] — **Times Cited: 2**
   By: Atlas, S. W.
   Magnetic resonance imaging of the brain and spine Volume: 1 Published: 2016
   Publisher: Lippincott Williams & Wilkins

5. **Lumbar spinal stenosis: anatomy and pathogenesis.** — **Times Cited: 36**
   By: Botwin, Kenneth P; Gruber, Robert D
   Physical medicine and rehabilitation clinics of North America Volume: 14 Issue: 1 Pages: 1-15, v Published: 2003-Feb

6. **Computer-aided diagnosis in medical imaging: Historical review, current status and future potential** — **Times Cited: 523**
   By: Doi, Kunio
   COMPUTERIZED MEDICAL IMAGING AND GRAPHICS Volume: 31 Issue: 4-5 Pages: 198-211 Published: JUN-JUL 2007

7. **Anatomy of the intervertebral foramen.** — **Times Cited: 22**
   By: Gilchrist, Russel V; Slipman, Curtis W; Bhagia, Sarjoo M
   Pain physician Volume: 5 Issue: 4 Pages: 372-8 Published: 2002-Oct

8. **Ground Truth Data, Content, Metrics, and Analysis** — **Times Cited: 4**
   By: Krig , S.
   Computer Vision Metrics: Survey, Taxonomy, and Analysis Pages: 283-311 Published: 2014

Publisher: Apress, Berkeley, CA

9. **COMPUTER DIAGNOSIS OF PRIMARY BONE TUMORS - A PRELIMINARY REPORT** Times Cited: 82
By: LODWICK, GS; HAUN, CL; SMITH, WE; et al.
RADIOLOGY Volume: 80 Issue: 2 Pages: 273-275 Published: 1963

10. **Fully Convolutional Networks for Semantic Segmentation** Times Cited: 1
By: Long , J.; Shelhamer , E.; Darrell , T.
ABS141142014 CORR Published: 2014
abs/1411.4,2014
Publisher: CoRR

11. **Predictors of early improvement in low back pain amongst consulters to general practice: the influence of pre-morbid and episode-related factors** Times Cited: 111
By: Macfarlane, GJ; Thomas, E; Croft, PR; et al.
PAIN Volume: 80 Issue: 1-2 Pages: 113-119 Published: MAR 1999

12. **The economic burden of back pain in the UK** Times Cited: 796
By: Maniadakis, N; Gray, A
PAIN Volume: 84 Issue: 1 Pages: 95-103 Published: JAN 2000

13. **MEASURING THE VC-DIMENSION OF A LEARNING-MACHINE** Times Cited: 134
By: VAPNIK, V; LEVIN, E; LECUN, Y
NEURAL COMPUTATION Volume: 6 Issue: 5 Pages: 851-876 Published: SEP 1994

14. Title: [not available] Times Cited: 695
By: Vapnik, V.
The Nature of Statistical Learning Theory Published: 2013
Publisher: Springer, NewYork, NY, USA

**Showing 14 of 14** **View All in Cited References page**