

# SPINESEGGAN: AUTOMATIC SEGMENTATION OF LUMBAR SPINE

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## ABSTRACT

Lumbar spinal stenosis is one of the many diseases that occur in the lumbar spine, it is a narrowing or constriction in the lumbar spine. MRI is preferred for its diagnosis. To treat the disease, surgery might be necessary, and surgeons need to know the different anatomical structures map prior to surgery. Researchers have tried to automate the segmentation of MRI images of the Lumbar Spine going as far back as 2014. However, a limited count of papers has been published in this domain that involve Artificial Intelligence / Machine Learning (AI/ML) on composite (T1 + T2) images and are available publicly for reproducibility and comparison. The objective of this research was to perform comparative evaluation of state-of-the-art AI/ML methods for segmentation of Lumbar Spine Stenosis. A publicly available dataset was selected, named Lumbar Spine MRI Dataset, for reproducibility. The dataset consisted of 1,545 composite T1 and T2 MRI images (combined) in the axial view. The combined images were of 515 patients. Our methods for comparison were basic U-Net, V-Net, and Pix2Pix Generative Adversarial Networks (Pix2Pix GAN). We improved the Pix2Pix GAN using U-Net (ResNet-50 backbone) as a generator, and a 5-layer deep CNN as a discriminator for the Pix2Pix GAN. Hyperparameter optimization was performed to find out the optimum number of layers and optimum value of parameters. Our metric was the DICE Score and IoU. Our results look promising; we got 0.93 (DICE Score) and 0.89 (IoU) with our improved model. The paper that released this public dataset had an overall IoU of 0.854 with SegNet. To the best of our knowledge, these are the only studies that used composite images (T1 + T2) for segmentation on this public, reproducible dataset. Our work is significant as it compares state-of-the-art methods on a benchmarked dataset, systematically, in this domain. For future work, we plan to validate our model on other public, reproducible datasets, if available. By segmenting the MRIs automatically, we can assist the surgeons in planning the surgery, faster and more accurately.

Keywords: Segmentation, Generative Adversarial Network (GAN), Artificial Intelligence (AI), Machine Learning (ML), Lumbar Spine

## INTRODUCTION

Segmentation is a method in artificial intelligence/machine learning (AI/ML), where the computer can outline or fill in a shape based on the input image. For example, if you have an image of a car on the road, then a segmentation model can segment out the image of the car that is on the road. Segmentation can be applied to many real-life problems such as assistance in medical diagnosis. Segmentation of various different anatomical structures in different images or scans that are taken during diagnosis can assist the doctors in identifying and/or planning their next steps. Similarly, this paper presents a unique model and the pro-posed application of the model in supplementing the knowledge of doctors in the spine.

The spine is an important aspect of human anatomy due to it holding the central nervous system. The central nervous system allows the brain to communicate to the rest of the body as the spine goes from the neck to the pelvic bone. The spine is split up into three parts the cervical, thoracic, and lumbar sections. In the lumbar section, there can be certain diseases that utilize a magnetic resonance image (MRI) to determine the severity and the treatment of the disease. One of those diseases is Lumbar Spine Stenosis (LSS), which is a disease that effects the back by causing the nerves to be constricted. LSS causes pain in the back which causes a decrease in posture movement. Another disease is Lumbar Disk Disease or Herniated Disk, which