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ORIGINAL RESEARCH

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An Enhanced RNN-LSTM Model for Fundus Image Classification to Diagnose Glaucoma

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Abstract

In the current medical implications, one of the leading ocular diseases is Glaucoma which majorly damage the Optic Nerve Head (ONH) of the eye retina. The intraocular pressure of the eye leads to glaucoma, which may lead to complete or partial vision loss. Regular screening and early detection is the only solution to avoid further vision loss. Due to the laborious and manual procedure in diagnosis, an automatic system is needed to diagnose glaucoma. This paper presents a novel method using deep learning-based RNN-LSTM classification model to develop an automatic approach to predict and classify the images to be as healthy or glaucomatous. The RNN and LSTM with dense, dropout, and batch normalization layers are used for training and testing the proposed prediction model. The RNN model is used for training the model and to overcome the problems that occur during training, the LSTM model is applied to increase the performance of the model. The proposed model achieved an accuracy of 97.4%, specificity of 97.9% and sensitivity of 97% in classifying the images. We have made use of the DRISHTI-GS database for training and testing the proposed model.

Keywords Deep learning · Glaucoma · Recurrent neural network (RNN) · Long short-term memory (LSTM)

Introduction

Medical imaging is a procedure and technique that aids in the creation of images of the human body's interior organs for various medical diagnostics. Many proceedings and the methodologies were applied to produce the medical data. This medical imaging is used in a variety of medical specialties, including ophthalmology [1]. It is one of the medical branches, in which it helps to detect eye problems. Glaucoma, diabetic retinopathy, cataracts, diabetic maculopathy, and other serious eye diseases exist. Glaucoma is a non-degenerative retinal disease that is one of the leading causes of vision impairment in worldwide. According to WHO, glaucoma [2–4] is the second leading eye disease which finally leads to blindness if there is no proper treatment in the proper duration. 75 million people already have suffered from glaucoma around the whole world and 10% of the people lost their vision without knowing about the disease. Hence, it is called as "Silent Thief of Sight" [5]. Once the person becomes blind due to the glaucoma, it cannot be cured. The glaucoma can affect from children to old people, there is no limitation in the age. But the people more than

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Study of Design and Analysis of S-glass Fiber Reinforced Epoxy Polymer Metal Laminate Composites in the Application of Propeller Shafts

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Abstract

The propeller shafts are utilized to transmit power from gear box to rear wheels in automobiles. It is found that the weight, cost, critical speed and buckling of shafts are the serious issues in conventional metallic propeller shafts. The propeller shafts made up of composite material are best suited for LMV due to single piece manufacturing. The fiber metal laminate propeller shafts are getting popular as the metal liner adds extra strength, rigidity and acts as a substrate and avoids leaking during manufacturing. The propeller shaft of light motor vehicle was selected for study. S-glass fibers, epoxy and a thin mild steel liner are the materials chosen. The design of the shaft was carried out according to ASME Standard code of design. The ply orientation and stacking sequence are selected as [±45°, 0°, 90°]$_s$ to increase the torsional strength, enhance natural frequency and buckling strength respectively. The finite element analysis of the propeller shaft is carried out in Ansys APDL. It is found from the analysis that the weight, torsional strength, torsional stiffness and natural frequency of the S-glass fiber reinforced Epoxy Metal Laminate (FML) composites are superior than the conventional C-35 alloy steel material, and hence can be an alternative to the conventional alloy steel shaft.

Keywords: Ansys APDL, ASME, FML, LMV

1. Introduction

In modern engineering, the quest for lightweight yet robust materials has become a focal point, particularly in the domain of propulsion systems for various industries. Propeller shafts, critical components in marine, aerospace, and automotive applications, are subjected to demanding operational conditions, including high torque, cyclic loading, and exposure to harsh environments. Traditional materials such as steel and aluminium have been extensively used for these applications; However, advancements in composite materials have paved the way for innovative solutions that offer superior performance characteristics.

Among these composites, S-Glass Fiber Reinforced Epoxy Polymer Metal Laminate Composites (S-GFRP-MLCs) have emerged as a promising alternative due to their remarkable combination of strength, stiffness, and corrosion resistance. This study aims to explore the design and analysis of S-GFRP-MLCs specifically tailored for use in propeller shafts, assessing their mechanical properties, structural integrity, and overall performance in comparison to conventional metallic shafts.

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