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НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ «КИЄВО-МОГИЛЯНСЬКА АКАДЕМІЯ»

Кафедра мультимедійних систем факультету інформатики

ПЕРЕВЕДЕННЯ RGB ЗОБРАЖЕНЬ У ГІПЕРСПЕКТРАЛЬНІ ЗА ДОПОМОГОЮ АЛГОРИТМІВ МАШИННОГО НАВЧАННЯ

Текстова частина до курсової роботи

за спеціальністю „ Комп’ютерні науки” 122

Керівник курсової роботи

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Тема: Переведення RGB зображень у гіперспектральні за допомогою алгоритмів машинного навчання

Календарний план виконання роботи:

№ п/п	Назва етапу курсового проекту (роботи)	Термін виконання етапу	Примітка
1.	Вибір теми курсової роботи	Січень 2023	
2.	Огляд літератури за темою роботи	Січень 2023	
3.	Пошук даних для навчання моделі	Лютий 2023	
4.	Розробка алгоритму	Лютий – березень 2023	
5.	Проведення обчислювальних експериментів.	Березень 2023	
6.	Написання пояснювальної роботи	Квітень 2023	
7.	Надання роботи керівнику для перевірки	Квітень 2023	
8.	Корегування роботи за результатами перевірки керівником	Травень 2023	
9.	Остаточне оформлення пояснювальної роботи та	Травень 2023	
10.	Створення презентації	Травень 2023	
11.	Захист курсової роботи	23 травня 2023	

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ABSTRACT

This work reviews the problem of reconstruction of hyperspectral images from RGB ones. The solution is proposed with a U-net model. Some experiments on the improvement of the performance are made. The model is used for the real case classification problem. Even though it did not improve the outcome of the second problem, the proper analysis of the problems faced and future solutions was made.

Keywords: Hyperspectral images, convolutional neural networks, U-net, EfficientNet, spectre, data augmentation

INTRODUCTION

Since the first humans on earth, people tried to visualize the world they see. A lot of various pictures drawn on the stones with coal or chalk are found. Later humanity discovered paints, which can be used to represent, how we see the world. Various artists could draw realistic pictures or add imagination and ideas to their works. The last method of representing the reflected light is a photograph. Imaging is a very complex type of data. The ability to capture such type of information using binary code humanity achieved recently. The progress does not stay still, and it reaches the stage when it is possible to create images of high quality that cannot be distinguished from reality. Such technologies opened opportunities for researchers to use these high-resolution data in various fields, such as face recognition, illness detection or self-driving cars. In recent years the image improved not only its spatial resolution but spectral as well. Hyperspectral images(HSI) began to increase their popularity. Such types of images that have broader spectra are currently used in lots of spheres. However, due to the fact that technology is new, the devices for that purpose are still expensive and very complex.

At the same time, In recent years, there has been growing interest in using machine learning(ML) techniques for analyzing and processing images. ML is being used more and more and being implemented in most spheres. These algorithms can use image data to produce solutions for tasks even better than humans.

One of the ideas to reduce the price of the HSI is to create an ML model that will transform RGB images into hyperspectral ones. In this work, the first task is to investigate this approach. U-net will be used with different variations tested to improve the performance, and various metrics will be evaluated. However, the main indicator of the model's success will show the second problem. In this work, the second model will try to classify the fundus RGB images to detect referable glaucoma. The first model will try to solve this task with RGB images, and the second one will use reconstructed HSI to classify the images. It is expected to receive better performance with the second model.

Overall, the main tasks are:

1) Investigating the usage of HSI
2) Review the existing solutions for HSI reconstruction
3) Implement the model
4) Experiment to get better performance

SECTION 1. APPLICATIONS OF HSI AND EXISTING METHODS FOR HSI RECONSTRUCTION

1. 1 HSI and its importance

Hyperspectral imaging(HSI) is a relatively new way of representing the information of the light reflected from the surface. Hyperspectral images contain information in a wide range of wavelengths across the electromagnetic spectrum, typically from the visible to the near-infrared range. RGB images, in contrast, have information only about three wavelengths that form a colourful, realistic image. However, using this technology, we omit a lot of important information. The universe does not live in RGB. All the material reflects light in all visible and invisible spectres. If we analyze an image thoroughly, we do not have three values for each pixel. This number could grow to infinity. The only limitation is distinguishing different wavelengths. Hyperspectral technology gives detailed information about objects in different spectra, which helps to gain additional data, which can be used to make much more precise conclusions.

Figure 1.1 RGB image and HSI [1]

One of the reasons why hyperspectral images are better for visual analysis is explained using one of the basic discrete mathematics concepts - the Pigeon-Hole Principle[2]. In the case of RGB images, we have only three bands with spectral information, while in the case of hyperspectral images number of bands may reach one hundred or even more. So, drawing parallels to the concept mentioned above, if we had twenty pigeons, we would not be able to distinguish them with only three holes that are offered by RGB image. At the same time, HSI gives us one hundred holes, where 20 pigeons can be easily placed separately. All in all, this concept leads to the conclusion that the more features we have, the better our problem may be solved. Hyperspectral images offer a vast amount of data when compared with RGB images.

The HSI was first used in the space exploration field. In 1987 [2] AVIRIS

spectrometer was launched. This invention opened access to more detailed information about various space objects and gave an opportunity for further deeper exploration of space. Since then, HSI found its application in many other fields.

Hyperspectral images can help to detect and identify objects and materials that may be difficult or impossible to see with traditional imaging techniques. This is because hyperspectral images capture information across a wide range of wavelengths, allowing for the detection of subtle spectral differences that can be used to identify different materials. This is particularly important in fields such as remote sensing, where the ability to detect and identify objects and materials from a distance can be crucial.