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REVOLUTIONIZING MATHEMATICS: EXPLORING THE IMPACT OF ARTIFICIAL INTELLIGENCE

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ABSTRACT

Mathematics has been transformed by the incorporation of artificial intelligence ai into several disciplines as has been the case in many other sciences this study examines how ai may be used in mathematics emphasising how it can improve mathematical algorithms improve problem solving skills and speed up the discovery of new mathematical ideas this research papers based on the complete working principle of ai in image processing mathematical issues can be solved more quickly and accurately by utilising ai techniques like machine learning deep learning and natural language processing which also leads to new discoveries ai algorithms can also help automate repetitive mathematical processes freeing up mathematicians to concentrate on higher level reasoning and exploratory research theorem proving mathematical optimisation data analysis and pattern recognition are only a few of the specific areas where ai has significantly improved mathematics that are covered in this paper in addition there are difficulties and moral issues furthermore the challenges and ethical considerations associated with the use of ai in mathematics are examined along with potential avenues for future research and development ultimately this research paper underscores the transformative potential of ai in mathematics paving the way for new methodologies and breakthroughs in this fundamental scientific discipline

Keywords - Artificial intelligence, Optimization, Revolution.

[1] INTRODUCTION

Artificial intelligence (AI) is a rapidly growing field that involves the development of intelligent machines that can perform tasks that typically require human intelligence mathematics plays a crucial role in (AI) as it provides the foundation for many of the algorithms and models used in machine learning and other AI applications in this paper we will explore the role of mathematics in AI with a focus on two specific applications image processing and recommendation systems image processing is a field of study that involves the analysis and manipulation of digital images Ai has revolutionized image processing by enabling machines to recognize and classify images with a high degree of accuracy one example of this is the use of Ai in measuring histological disease activity in ulcerative colitis 2 in this study an ai system was developed using image processing and machine learning algorithms to measure histological disease activity based on the nancy index the system was found to be highly accurate and could potentially be used to improve the diagnosis and treatment of ulcerative colitis another application of ai that involves mathematics is recommendation systems these systems use machine learning algorithms to analyse user data and provide personalized recommendations for products or services one example of this is the use of ai in the e commerce industry where recommendation systems are used to suggest products to customers based on their browsing and purchase history a study by zhang et al 1 provides an overview of the current developments and new directions in the field of recommender systems using ai the study highlights the importance of using advanced mathematical models and algorithms to improve the accuracy and effectiveness of recommendation systems in conclusion ai is a rapidly growing field that relies heavily on mathematics image processing and recommendation systems are just two examples of how ai is being used to solve complex problems and improve the efficiency and accuracy of various industries as ai continues to evolve it is likely that we will see even more applications of mathematics in this field.

[2] IMAGE PROCESSING

What is image processing?

Image processing is the manipulation of digital images to enhance their quality extract useful information or perform other tasks it is a vast field with many different techniques but some of the most common include:

- filtering this involves applying a mask to an image to blur sharpen or otherwise modify the pixels
- segmentation this involves dividing an image into different regions based on their properties such as color texture or brightness
- feature extraction this involves identifying and extracting important features from an image such as edges corners or objects
- object recognition this involves identifying and classifying objects in an image

Machine learning ML can be used to improve the performance of image processing tasks in a number of ways for example ml can be used to:

1. Automatically learn the parameters of an image processing filter this can be done by training a machine learning model on a set of images that have already been processed with the desired filter
2. Identify and classify objects in an image this can be done by training a machine learning model on a set of images that have already been labelled with the objects they contain

Python is a popular programming language for image processing because it has a number of libraries that provide powerful tools for image manipulation some of the most popular python libraries for image processing include

Open cv this is a free and open-source library that provides a wide range of image processing functions.

Scikit image this is a python library that provides a number of image processing functions that are built on top of numpy

Pillow this is a python library that provides a high-level interface for image manipulation

By combining the power of ml with the flexibility of python it is possible to create powerful image processing applications that can solve a wide range of problems
Here are some examples of how ml and python are used to process images:
Face recognition this is a popular application of ml and python for image processing face recognition systems use ml to identify and classify faces in images this technology is used in a wide range of applications such as security systems social media and mobile devices.

Object detection this is another popular application of ml and python for image processing object detection systems use ml to identify and classify objects in images this technology is used in a wide range of applications such as self-driving cars robotics and video surveillance

Medical imaging ml and python are also used in medical imaging to improve the diagnosis and treatment of diseases for example ml can be used to automatically detect tumours in medical images such as x rays and MRI scans

These are just a few examples of how ml and python are used to process images as ml and python continue to develop we can expect to see even more innovative applications of these technologies in the field of image processing

Why do we process images?

Image Processing has been developed in response to three major problems concerned with pictures:

- Picture digitisation and coding to facilitate transmission, printing and storage of pictures;
- Picture enhancement and restoration in order, for example, to interpret more easily pictures of the surface of other planets taken by various probes;
- Picture segmentation and description as an early stage to Machine Vision.

Image Processing nowadays refers mainly to the processing of digital images.

What is an image?

A panchromatic image is a 2D light intensity function (x, y), where x and y are spatial coordinates and the value of f at (x, y) is proportional to the brightness of the scene at that point. If we have a **multispectral image**, f(x, y) is a vector, each component of which indicates the brightness of the scene at point (x, y) at the corresponding **spectral band**.

What is a digital image?

A **digital image** is an image f (x, y) that has been discretised both in spatial coordinates and in brightness. It is represented by a 2D integer array, or a series of 2D arrays, one for each colour band. The digitised brightness value is called **grey level**.

Each element of the array is called **pixel** or pel, derived from the term "picture element".
Usually, the size of such an array is a few hundred pixels and there are several dozens of possible different grey levels. Thus, a digital image looks like

$$f(x,y) = \begin{bmatrix} f(1,1) & f(1,2) & \dots & f(1,N) \\ f(2,1) & f(2,2) & \dots & f(2,N) \\ \vdots & \vdots & & \vdots \\ f(N,1) & f(N,2) & \dots & f(N,N) \end{bmatrix} \quad (1.1)$$

this $0 \leq f(x, y) \leq G-1$, where usually N and G are expressed as positive integer powers of 2 ($N= 2^n$, $G = 2^m$).

What is spectral band?

A colour band is a range of wavelengths of electromagnetic spectrum, over which the sensors we use to capture an image as nonzero sensitivity. Typical colour image consists of 3 colour band. This means that they have been captured by 3 different sets of sensors each set made to have a different sensitivity functions.

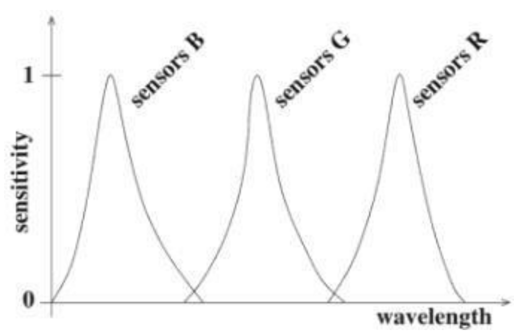

Figure 1.1: The spectrum of the light which reaches a sensor is multiplied with the sensitivity function of the sensor and recorded by the sensor. This recorded value is the brightness of the image in the location of the sensor and in the band of the sensor. This figure shows the sensitivity curves of three different sensor types. **Why do most image processing algorithms refer to grey images, while most images we come across are colour images?**

For various reasons.

1. A lot of the processes we apply to a grey image can be easily extended to a colour image by applying them to each band separately.

2. A lot of the information conveyed by an image is expressed in its grey form and so colour is not necessary for its extraction. That is the reason black and white television receivers been perfectly

acceptable to the public for years and black and white photography is still popular with many photographers.

3. For many years colour digital cameras were expensive and not widely available. A lot of image processing techniques were developed around the type of image that was available. These techniques have been well established in image processing

The wavelengths of the photons that reach the pixel location of each triple sensor, as identified in figure 1.3 are:

Location (1, 1): $\lambda_0,\lambda_9,\lambda_9,\lambda_8,\lambda_7,\lambda_8,\lambda_1,\lambda_0,\lambda_1,\lambda_1$
Location (1, 2): $\lambda_1,\lambda_3,\lambda_3,\lambda_4,\lambda_4,\lambda_5,\lambda_2,\lambda_6,\lambda_4,\lambda_5$
Location (1, 3): $\lambda_6,\lambda_7,\lambda_7,\lambda_0,\lambda_5,\lambda_6,\lambda_6,\lambda_1,\lambda_5,\lambda_9$
Location (2, 1): $\lambda_0,\lambda_1,\lambda_0,\lambda_2,\lambda_1,\lambda_1,\lambda_4,\lambda_3,\lambda_3,\lambda_1$
Location (2, 2): $\lambda_3,\lambda_3,\lambda_4,\lambda_3,\lambda_4,\lambda_4,\lambda_5,\lambda_2,\lambda_9,\lambda_4$
Location (2, 3): $\lambda_7,\lambda_7,\lambda_6,\lambda_7,\lambda_6,\lambda_1,\lambda_5,\lambda_9,\lambda_8,\lambda_7$
Location (3, 1): $\lambda_6,\lambda_6,\lambda_1,\lambda_8,\lambda_7,\lambda_8,\lambda_9,\lambda_9,\lambda_8,\lambda_7$
Location (3, 2): $\lambda_0,\lambda_4,\lambda_3,\lambda_4,\lambda_1,\lambda_5,\lambda_4,\lambda_0,\lambda_2,\lambda_1$
Location (3, 3): $\lambda_3,\lambda_4,\lambda_1,\lambda_0,\lambda_0,\lambda_4,\lambda_2,\lambda_5,\lambda_2,\lambda_4$

Let's calculate the values that takes sensor array will record and thus produce the 3 photon energy band recorded.

We denote by gx (i , j) the value that will be recorded by sensor type X at location (i,j).
For sensor R,G and B in locations (1,1), the recorded values will be:

$$g_R(1,1) = 2E\lambda_0 \times 0.0 + 2E\lambda_9 \times 0.6 + 2E\lambda_8 \times 1.0 + 1E\lambda_7 \times 0.8 + 3E\lambda_1 \times 0.1 \quad (1.2)$$
$$= 1.0 \times 0.6 + 1.2 \times 1.0 + 0.7 \times 0.8 + 2.85 \times 0.1$$
$$= 2.645$$
$$g_G(1,1) = 2E\lambda_0 \times 0.0 + 2E\lambda_9 \times 0.0 + 2E\lambda_8 \times 0.3 + 1E\lambda_7 \times 0.0 + 3E\lambda_1 \times 0.2 \quad (1.3)$$
$$= 1.2 \times 0.3 + 0.7 \times 0.6 + 2.85 \times 0.2$$
$$= 1.35$$
$$g_B(1,1) = 2E\lambda_0 \times 0.2 + 2E\lambda_9 \times 0.0 + 2E\lambda_8 \times 0.0 + 1E\lambda_7 \times 0.0 + 3E\lambda_1 \times 0.4 \quad (1.4)$$
$$= 2.0 \times 0.2 + 2.85 \times 0.4$$
$$= 1.54$$

Working in a similar way, we deduce that the energies recorded by the three sensor arrays are:

$$E_R = \begin{pmatrix} 2.645 & 2.670 & 3.729 \\ 1.167 & 4.053 & 4.576 \\ 4.551 & 1.716 & 1.801 \end{pmatrix}$$
$$E_G = \begin{pmatrix} 1.350 & 4.938 & 4.522 \\ 2.244 & 4.176 & 4.108 \\ 2.818 & 2.532 & 2.612 \end{pmatrix}$$
$$E_B = \begin{pmatrix} 1.540 & 5.047 & 1.138 \\ 4.995 & 5.902 & 0.698 \\ 0.536 & 4.707 & 5.047 \end{pmatrix} \quad (1.5)$$

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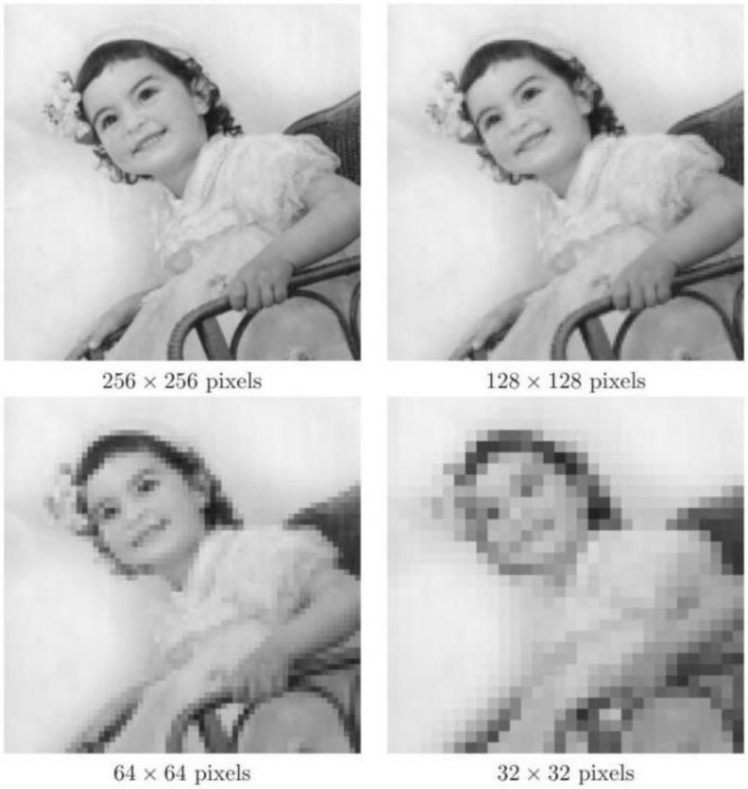

Figure 1.4: Keeping the number of grey levels constant and decreasing the number of pixels with which we digitise the same field of view produces the checkboard effect.

Why are image often quoted as being 512×512, 256×256, 128×128 etc?

Image resolutions are often quoted as being 512 x 512 , 256 x 256 , 128 x 128 etc because these are common resolutions for images used in computer vision and machine learning applications these resolutions are large enough to capture enough detail for most tasks and small enough to be processed quickly and efficiently by computers.

For example a 512 x 512 image has a total of 262,144 pixels this is a lot of data for a computer to process but it is still manageable for most modern machines a 128 x 128 image on the other hand only has 16,384 pixels this is much less data and it can be processed much more quickly the specific resolution that is used for an image will depend on the specific application for example an image that is used for **object detection** may need to be a **higher resolution** than an image that is used for **facial recognition** here are some of the reasons why image resolutions are often quoted as being 512 x 512, 256 x 256, 128 x 128 etc

- These resolutions are large enough to capture enough detail for most tasks
- These resolutions are small enough to be processed quickly and efficiently by computers
- These resolutions are common and widely supported by software applications

What determines the quality of an image?

The quality of an image is a complicated concept, largely subjective and very much application dependent. Basically, an image is of good quality if it is not noisy and (I) it is not blurred;

1. It has high resolution.
2. It has good contrast.

What makes an image blurred?

Image blurring is caused by incorrect image capturing conditions, For example, out of focus camera, or relative motion of the camera and the imaged object. The amount of image blurring is expressed by the so-called point spread function of the imaging system.

What is meant by image resolution?

The resolution of an image expresses how much detail we can see in it and clearly depends on the number of pixels we use to represent a scene (parameter N in equation (1.6)) and the number of grey levels used to quantise the brightness values (parameter m in equation (1.6)

Keeping m constant and decreasing N results in the **checkerboard effect** (figure 1.4). Keeping N constant and reducing results in **false contouring** (figure 1.5). Experiments have shown that the more detailed a picture is, the less it improves by keeping N constant and increasing m. so, for a detailed picture, like a picture Of crowds (figure 1.6), the number of grey levels we use does not matter much.

[3] SUMMARY

In this research paper, the complete knowledge is given to understand about the whole concept of how the participation of artificial intelligence in the world of mathematics. How the artificial intelligence is helping in developing/ processing the image in the field of mathematics. The whole concept is this , the participation of artificial intelligence in mathematics to make it much simpler and easy to understand**.**

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