Digital Analysis of Paintings

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***Abstract*—**

I. Introduction

Digital image processing is a field which encourages the crossover of different scientific disciplines, often biological research and computer vision align to automate the collection and analysis of plant growth. However, art and computing are fields which, at first glance, have very little in common.

But a deeper look unveils a plethora of different avenues from detecting forgeries to being able to date an artists work within a catalogue of their known pieces.

This survey paper will unearth some techniques which can be applied to the digital analysis of paintings, as well as existing research which has already applied computer vision to the field of art.

II. Colour Analysis

Digital images are typically considered to be a matrix of pixels, where each pixel contains information about the colour of that place in the image.

Colours can be represented in numerous different ways, but are typically three to four bytes; for example the Red, Green, Blue (RGB) colour space uses one byte for the levels of red, one for green and one for blue. The fourth byte is unlikely to be considered in artwork as it usually represents the transparency, known as the alpha channel, of the pixel.

A single byte colour space purely focuses on the intensity of a pixel, in actuality this represents a grayscale image.

Analysing colour is the base of all analysis techniques in image processing, the value(s) of a pixel with regards to its location and neighbours can be used to build up some very complex knowledge about the image. This section will deal specifically with the colours which an artist uses within their work, such as looking at the distribution of colours across a work, rather than using colour information to determine textures.

A. Colour Distribution

The distribution of colour across an image can give a surprising amount of information about that image, especially given that colour is very subjective to an individual.

Ivonna, Stanchev and Dimitrov investigated the colour distribution within the works of over 100 artists for several different countries and periods, using a system named Art Painting Image Color Semantics (APICSS)[1].

Existing systems already statistically analysed colours within an image and some even used classifiers, typically a naive Bayesian classifier as it fits well with statical methods, to perform extra analysis.

Unlike these existing system, APICSS focused primarily on the Hue, Saturation, Luminance (HSL) colour space as it is the closest representation to an artist's colour wheel. Hue, Saturation, Value (HSV) was also considered, but because the lightness is not symmetrical within the HSV colour space, it is less useful for direct comparison.

As with any system involving classification, a feature space is needed to represent an item within the data set. In the case of APICSS the feature space is three dimensional, one for each of the values in the colour space.

From this, a distance measure (in this case Euclidean distance) can be used to compare different items.

APICSS also take into account some of the metadata attached to each painting, such as the movement and sub-movement during which the painting was created. This allows for more statistical analyses to be performed on sub-sets of the data set.

APICSS appears to be a good system, which considers both metadata and analysis gained from the digitisation of artwork. The paper considers a wide range of artists and periods.

However, the use of a lossy image format (JPEG) could potentially skew the results. The system itself is very basic, especially if it only considers HSL and metadata. This is further compounded by only considering thirteen colours within the Hue (twelve separate colours and one achromatic).

Despite having a decent sized data set overall, some of the categories have relatively small items within them.

Overall APICSS is a good application of existing research, but uses very basic analysis techniques on the images themselves.

B. Pigment Mapping

C. Difference Visualisation

III. Texture Analysis

Paintings are somewhat unlike the normal subject for image processing, whilst most images are either simple two dimensional images, or two dimensional slices of a three dimensional

object. Paintings often thought of as two dimensional, but with many paint types these paintings become three dimensional.

This aspect is lost in the digitisation of the painting; but there are still ways of analysing the texture of the image.

A. Steerable Filters

B. Gabor Filters

C. Histograms of Edge Orientated Gradients

D. Multifractal Classification

E. Texton-Based Analysis

IV. Statistical Analysis

A. Stylistic Analysis

B. Authentication of Artwork

C. Dating an Artist's Work

V. Brushstroke Analysis

A. Artistic Identification

B. Rhythmic Brushstrokes

References

[1] K. Ivanova, P. L. Stanchev, and B. Dimitrov, "Analysis of the distributions of color characteristics in art painting images," *Serdica Journal of Computing*, vol. 2, no. 2, pp. 111–136, 2008.