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RESEARCH ON THE EXISTING IMAGE CLASSIFICATION METHODS

Abstract. Image classification is a topical issue in data science, which is applied in many areas. It is the process of getting classes of information from a multichannel bitmap using specific rules. There are three approaches to image classification - supervised, unsupervised and object-based. Support Vector Machines, Artificial Neural Network, Decision Tree, Convolutional Neural Network are the solution methods used for image classification. Choice of the classification approach depends on the way an analyst interacts with the computer. The whole process boils down to image stack acquisition, preprocessing and classification.

Keywords: image processing, Support Vector Machines, Artificial Neural Network, Decision Tree, Convolutional Neural Network.

Introduction

The problem of image classification consists in getting the image as an input and outputting its class or a group of probable classes that best characterize the image. For people, this is completely natural and simple. It is one of the first skills from birth. On the contrary, the computer "sees" only the pixels of the image, which have different colors and intensity. The classification process falls down into the following steps: preprocessing of digital data, feature extraction, selection of training data, decision and classification.

Supervised classification uses spectral signatures obtained from training samples. It means that the user can select sample pixels in an image and use them as references for the classification of all other pixels.

Unsupervised classification finds spectral classes (or clusters) in the multi-image without the analyst's intervention. The computer uses special techniques to determine the related pixels and group them into classes.

Object-based classification segments an image by grouping pixels based on their spectral characteristics and generates objects with different geometries.

At the same time, it is hard to determine and classify an object, because of the variation between the images of same class, viewpoints, scales or background clutter.

Image classification solves various problems in such areas as medicine, environmental change, education, agriculture, object detection and security.

Related work

The paper by Sunayana G. Domadia [1] describes supervised and unsupervised image classification techniques by implementing and analyzing their accuracy and time. The author uses the k-means algorithm based on a minimum distance while other algorithms are based on probability distribution.

Desheng Liu et al. [2] explain the advantages and the limitations of an object-based approach in image classification, in comparison with a pixel-based approach. Their conclusion is based on the differences in the classification functions and classification units.

The paper by Abass Olaode [3] identifies dimension reduction and clustering algorithms as the main classes needed in unsupervised image classification.

Le Hoang Thai [4] describes image classification in terms of the process of implementing Artificial Neural Network together with Support Vector Machine.

Farhana Sultana [5] explains the use of different Convolutional Neural Network architectures for image classification.

The paper by Majid Shadman Roodposhti [6] shows the assessment techniques which do not depend on the test data. It compares the efficiency of using deep neural networks (DNN) with the well-known random forest (RF) technique.

Image classification process

The stages of image classification are digital data, preprocessing, feature extraction, selection of training data, decision and classification, classification output and accuracy assessment. As demonstrated in Figure 1, the first stage is about downloading image files from the web. Then damaged and non-image files, small images should be removed, large images should be downscaled, and the remaining part should be encoded in RGB. The third stage is the determination or computation or finding out the characteristics from the image sample. The next stage describes the choice of the specific attribute that best characterizes the pattern. Then in the decision and classification stage the detected objects are classified into predetermined classes by applying an appropriate method. This method compares image sample with the target one. The classification output is the prediction result with a suitable label attached to the object. The last stage, called accuracy assessment, describes the recognition of probable sources of errors. Also, it is used in the comparison as a detector.

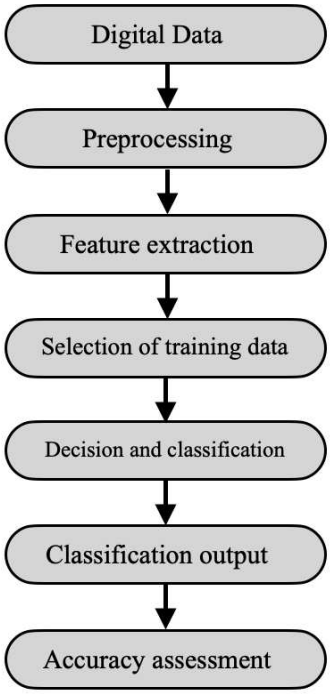

Figure 1 - Image classification steps

Application

Image classification is applied in different areas such as:

- Automatic control in production applications;
- Assisting humans with identification tasks such as a species identification system;
- Control processes for industrial robots;
- Event detection for visual observation or people counting;
- Interaction tasks for human-computer interaction devices;
- Modeling objects or environments, such as medical image analysis or topographic modeling;

• Navigation by an autonomous vehicle or a mobile robot;
• Organizing information for indexing image databases and image sequences.

Most popular classification methods

Convolutional Neural Network (CNN) is the most famous model applied in image classification. The main advantage of CNN is that the model understands the image on the local level. A small number of parameters significantly reduces the time and the amount of data needed to train a model.

Support Vector Machines (SVM) are the supervised learning models, where the algorithm builds hyperplanes to divide the data into classes. SVM is accurate in high dimensional spaces and uses memory effectively because of a subset of training points in the decision function.

Artificial Neural Network (ANN) is a computing system that comes from biological neural networks. ANN have adaptive weights on the way between neurons, that can be regulated by a learning algorithm. To improve the model, this algorithm learns from the observed data.

Decision Trees (DT) is a supervised learning technique, that can train samples and create a decision tree. DT consists of levels called root nodes, sub-nodes and leaves. The nodes are connected by branches that show the classification direction.

Benefits and drawbacks

Table 1 below presents a comparison of the benefits and drawbacks of various image classification methods.

Table 1 - Classification methods comparison

	Advantages	Disadvantages
Convolutional Neural Network (CNN)	automatically detects the important features, computationally efficient, highly accurate	high computational cost
Support Vector Machines (SVM)	effective in high dimensional spaces, memory efficient, less risk of overfitting	not suitable for and takes a long training time with large data sets, depends on noise
Artificial Neural Network (ANN)	parallel processing capability, a distributed memory, very efficient for large data sets, robust to noise in the training data	high computational cost
Decision Trees (DT)	requires less effort for data preparation during pre-processing, does not require normalization of data	Takes longer time to train a model, a small change in data can cause a large change in the structure

Conclusion

In this paper we have analyzed the supervised, unsupervised and object-based approaches to image classification. We have defined the most popular classification methods and have figured out their benefits and drawbacks. This will help researchers choose the most suitable classification method according to their requirements.

Convolutional Neural Networks and Artificial Neural Networks are most suitable and popular methods for solving image classification problems. One of their common disadvantages is high computational cost, but the benefits of using them are much greater.

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Қолданыстағы бейнелерді жіктеу әдістерін зерттеу

Аңдатпа. Кескіндерді жіктеу – көптеген салаларда қолданылатын деректанудағы өзекті тақырып. Бұл нақты ережелерді қолдана отырып, көп жолақты растрлық картадан ақпарат алу процесі. Кескінді жіктеудің үш әдісі бар: бақыланатын оқыту, бақылаусыз оқыту және объектілік. Олардың қолданылуы классификация кезінде талдаушының компьютермен өзара әрекеттесуіне байланысты болады. Процестің барлығы кескіндер стегін алудан, алдын ала өңдеу мен жіктелуден тұрады. Тірек векторлық машиналар, жасанды нейрондық желілер, шешім ағаштары, конволюциялық нейрондық желілер – кескіндерді жіктеу әдістері.

Түйінді сөздер: кескінді өңдеу, тірек векторлық машиналар, жасанды нейрондық желі, шешім ағашы, конволюциялық нейрондық желі.

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Исследование существующих методов классификации изображений

Аннотация. Классификация изображений является актуальной темой в науке о данных, которая применяется во многих областях. Это процесс получения классов информации из многоканального растрового изображения с использованием определенных правил. Существует три метода классификации изображений: обучение с учителем, обучение без учителя и объектный. Их применение зависит от того, как аналитик взаимодействует с компьютером во время классификации. Весь процесс состоит из получения стека изображений, предварительной обработки и классификации. Машины опорных векторов, искусственная нейронная сеть, дерево решений, сверточная нейронная сеть — все это методы классификации изображений.

Ключевые слова: обработка изображений, машины опорных векторов, искусственная нейронная сеть, дерево решений, сверточная нейронная сеть.

Авторлар туралы мәлімет:

Салерова Диана Кайратовна, бакалавр, «Компьютерлік инженерия және ақпараттық қауіпсіздік» кафедрасының магистрлік студенті, Халықаралық ақпараттық технологиялар университеті.

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