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Development and Research of Methods and Algorithms for Intelligent Systems for Complex Structured Images Classification

R.A. Tomakova, S.A. Filist and A.I. Pykhtin
Department of Technical Sciences, Southwest State University, Kursk, Russia

Abstract: Intelligent classification system for complex structured images designed to highlight the image of a given segment class. It belongs to the training systems of classification. The development urgency of complex structured image classification in intelligent systems occurs in the processing of images from cameras UAV used for navigational purposes in the absence of an artificial earth satellite or the analysis of images in real time by the operator. In this case, there are high demands not only for the quality classification of objects in images, but also to speed identification and classification of the investigated image segments. The contradiction between the effectiveness (classification accuracy) and computing resources offered solved by a distributed computing system (network). The method is built on the idea of hybrid trekking to data processing and aggregation of "weak" classification algorithms in the "strong" algorithms.

Key words: Classification of images, hybrid methods of processing image classification, classifier learning algorithm, navigational, quality, classification

INTRODUCTION

For a successful image classification requires a priori information about the structure and properties of the world. However, many factors (shape deformation, overlap of the transition to the scene 2 and 3D images, etc.) reduce the data value and a priori difficult semantic image segmentation in which each segment is regarded as an object of a certain class. As a result, the image has an alternative structure, the decision on the selection of one of them cannot be accepted unequivocally, based on received picture. We define the class as a complex structured images (Tomakova, 2011). Therefore, if the image is complex structured, it leads to a significant quality reduction of its classification or the classification of its segments by trained classifiers (Akimov, 2014).

Special importance of development classification methods of complex structured image occurs in the images processing from Unmanned Cameras Aerial Vehicles (UAV), used for navigational purposes in the absence of an Artificial Earth Satellites (AES) or in the analysis of images in real time by the operator (Filist, 2015; Dyudin, 2014a, b; Tomakova, 2012). In this case, there are high demands not only for the quality classification of objects in images but also to speed identification and classification of the investigated segment. Unfortunately, very often, these requirements contradict each other.

Intelligent system for processing complex structured images must perform the following tasks: isolating an object in the image; classification of the selected object to a class. However, these problems can be solved by an algorithm (one stage): segmentation+classification or they can be addressed sequentially: segmentation→ classification (in two stages). There are currently quite a lot of methods and algorithms to solve these problems. Unfortunately, the most effective ones is not possible to implement on a desktop PC as most of these methods is based on the window transforms pixel attributes and involves large-scale transformation of the original windows which requires enormous computing resources. A similar method is used.

MATERIALS AND METHODS

The contradiction between the effectiveness (classification accuracy) and computing resources offered solved by a distributed computing system (network). The method is built on the idea of hybrid trekking to the processing of data, sound in and the aggregation of "weak" classification algorithms. It is proposed to replace the centralized processing of distributed data processing c its subsequent centralization as the association "weak" algorithms "strong". It is supposed to process a grayscale image with the segmentation and classification of objects in an image to use two sources of data, allowing to build two independent feature space: the texture data and data on the geometry of the image segment. To decentralize the image data is divided into rectangular segments-cell

Corresponding Author: R.A. Tomakova, Department of Technical Sciences, Southwest State University, Kursk, Russia

analysis of pixels which conducted a separate processor. With the increasing size of the cells is a "strengthening" classification algorithm. If the construct so called "greedy" algorithm (Kazakovtsev, 2015; Dyudin, 2014a, b) in which each iteration is chosen the best solution in the presence of only three algorithms, each of which correctly solves two alternatives classification p probability independently of the others then the classification of the object may eight outcomes. If these algorithms are aggregated on a "vote" that is attributed to the class object which was voted for most algorithms, the probability of a correct answer q, obtained by aggregation is:

$$q = p^3+3p^2(1-p) = p^2(3-2p) \quad (1)$$

RESULTS AND DISCUSSION

Figure 1 shows a probability plot of correct decisions q aggregated algorithms of the correct solutions probability p for original algorithms.

Figure 1 shows that if the probability of a correct decision at least slightly larger than 0.5, the classification of the quality of composition can be significantly greater as a separate algorithm. Moreover, it has been found empirically that the successfully formulated composition classification quality can continue to grow even when the training sample on absolutely accurate classification.

Distributed image analysis method. To implement the method of distributed analysis the original image is divided into rectangular cells. Cells size depends on the subject area and the original image size. The cell size can be taken 24×24 pixel as is customary in the classifier Viola-Jones. Each cell is associated processor which performs the image texture analysis and contour analysis algorithms implementing images. The processor in each cell processes the image pixels sequentially in two ways. As a result of the processing space informative features formed in the cells, allowing include the image fragment in the cell to a particular class. Using the method of processing depends on the desired class. In the particular case, the class can be defined in two spaces informative features, defined by two processing methods.

At first level distributed system formed "weak" classifiers. To form a "strong" classifiers need to combine adjacent cells, classified "weak" classifiers to one and the same class. On the basis of such an association formed by the new "windows" non-rectangular shape. In each such "window" to work as processors as the source of "windows" have been integrated into this "window" a "window" of the upper hierarchical level. The next step is the classification of image processing is carried out in a

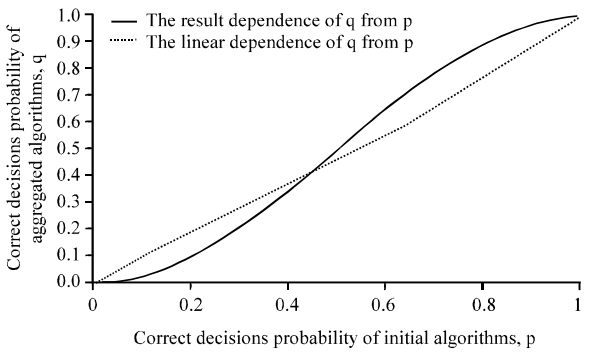

Fig. 1: Graph (thick line) probability of correct decisions q aggregated algorithms on the probability p of correct solutions of initial ("weak") algorithms

newly received "windows" as two different ways, two spaces are constructed and informative features on each space of informative attributes the decision to the image fragment accessory box to the desired class. Consolidation of "windows" occur as long as the entire passage o f the desired class will not fall in the "window".

After entering the image is its division into cells. The number of cells is determined by the maximum number of processors used and the specifics of the image. Then set three threshold classification errors. The first threshold corresponds to a strong classification class "not A". The second threshold corresponds to a weak classification class "A". The third threshold corresponds to a strong classification 'A' class. Each cell correspond to four flags are initially set to zero. Set in one of the flag 1 is the fact that the cell is related to a class "A" weak classifier of the first method of classification. Set in one of the flag 2 corresponds to that cell is assigned to the class "A" weak classifier of the second method of classification. In a series of organized unit 6, a cell classification is performed in two ways. Thus, depending on the classification results, appropriate flags are set to the appropriate state.

If the cell is a cell belonging to the test set strong class classifier, the flag unit 4 is installed. After setting the flags of all cells is performed in the aggregation condition corresponding weak classifiers, i.e., aggregation classifiers performed only in those cells in which one of the flags 1 and 2 or both are in unit state. If this condition is not satisfied, it is considered that the cell belongs to the class, "NOT A" or "A" strong classifier. If the error does not exceed the aggregated classification threshold corresponding to the error, allowing the union of cells for "A" class, the flag of the cell 3 is set to one.

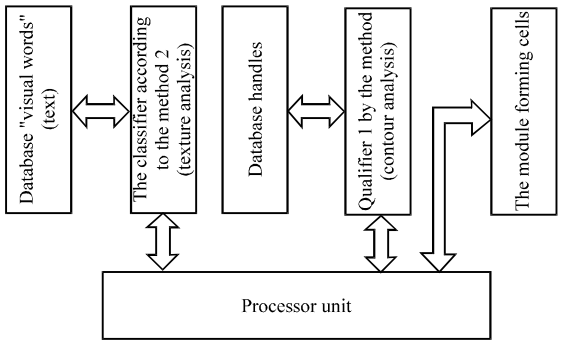

Fig. 2: Block diagram of intelligent classification system complex structured images

Cell count is then performed which flag is stored in the three state unit, after which the procedure proceeds to merging the cells realized in cycle. The union takes place only two adjacent cells.

Merge cells process continues until, until all image pixels are not divided into two classes: "NOT A" and "A" either weak or strong classifiers. Figure 2 shows a block diagram of an intelligent system of complex structured images classification.

It implements two methods of image analysis by two classification modules and two databases. The first classification module is based on the edge image analysis and works with a descriptor data. The second classifier performs texture analysis and work with the database Texton "visual words". Each processor unit CPU is connected with his image cell. The structure of the processor unit is adapted to the structure of the image cells and image cells are formatted according to the results of the work of classifiers.

CONCLUSION

Summary: A method for distributed image analysis, which combines the high speed of data processing, achieved through a multi-parallel processing of data fragments as well as high accuracy is achieved through aggregation classifiers solutions adaptable pyramid data structure.

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