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Research Article

Algorithm for Recognition of Movement of Objects in a Video Surveillance System Using a Neural Network

S. Harish,[1] C. Anil Kumar,[1] Lakshmi Shrinivasan,[2] S. Rohith,[3] and Belete Tessema Asfaw[4]

[1]*Department of Electronics and Communication Engineering, R. L. Jalappa Institute of Technology, Kodigehalli, Doddaballapur, Karnataka 561203, India*
[2]*Department of Electronics and Communication Engineering, Ramaiah Institute of Technology, Bengaluru, Karnataka 560054, India*
[3]*Department of Electronics and Communication Engineering, Nagarjuna College of Engineering and Technology, Bengaluru, Karnataka 562164, India*
[4]*Department of Chemical Engineering, Haramaya Institute of Technology, Haramaya University, Haramaya, Ethiopia*

Correspondence should be addressed to Belete Tessema Asfaw; belete.tessema@haramaya.edu.et

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The aim of this article is to address the problem of protecting the private property of a protected object, namely: we propose an algorithm for detection of object movements by means of a neural network for the video surveillance system. Consistency of perception of the external world in the form of images allows for the investigation of properties of the limited number of objects on the basis of familiarization with their final number. Based on the literature analysis, the main definitions of the theory of image recognition were established, such as "image," "sign," and "vector realization." A comparison is made of approaches, methods, and technologies for recognizing the movement of objects, and their strengths and weaknesses are discussed. It was found that the neuron network is the most effective method for solving the problem of recognition of the movement of objects due to the accuracy of the result, simplicity, and speed. On the basis of the structural scheme of the complex algorithm of processing and analysis of images, the algorithm for recognition of the motion of objects by means of a neural network for the system of video observation is developed.

1. Introduction

In today's world, the slogan is becoming more and more relevant. This applies to all spheres of activity and human life. Security of the object being protected is one of its components, and video surveillance is one of the ways to maintain security at the appropriate level [1]. The surveillance system is a set of hardware and software designed to monitor the territory, activities, and situation. Traditional video surveillance systems are widespread in today's security agencies and show a high level of protection but have their own shortcomings: as a result, the large amount of recorded video material requires a high amount of memory and time to analyze and view. Our research is focused on improving the efficiency of video surveillance systems [2]. The video surveillance information system is based on modern cybernetic methods and technologies, namely, machine learning [1], computer vision theory [2], and the theory of image recognition [3].

The work of F. Rosenblatt must be noted among foreign scientists; he proposed in 1957 a perfect machine for the recognition of images. It was the simplest model of human brain activity. A significant contribution to the further development of the theory of image recognition was made by W. Gardner. The identification of object movements is an extremely complex task, but all of them rely on neural measurements, which allows for more accurate results in a short period of time. This is confirmed by the practical experience of the authors. The aim of this research is to develop and create an algorithm for recognition of objects' movements by means of a neural network for video surveillance systems [3]. Artificial neural networks are

composed of nodes or units that resemble the neurons in a biological brain. A signal can be transmitted from one artificial neuron to another through each connection, just as it would be in a biological brain.

1.1. Theoretical Foundations of Research. Pattern recognition theory is a branch of cybernetics devoted to creating theoretical foundations for the classification and identification of objects. The processes of classification and identification are called recognition, and objects are called things. Based on the research of the authors, we shall identify the main definitions and give a short description of each method of the theory of image recognition. A pattern is a model that reproduces the properties of the object being recognized. An image is characterized by a multiplicity of recognition features, which create a structured vector-image realization. Often the image is replaced with a recognition class. The feature of recognition is a characteristic of a certain property of the object being analyzed. Vector realization of an image is a structured, i.e., ordered, sequence of recognition features, which will be presented in the form of a vector row or vector carrier. System image recognition—a complex electronic and computational method—is capable of modelling mental processes in humans during decision making with the aim of detecting analogies among the surveyed objects [4]. For image recognition, it is necessary to solve two main tasks: to divide the space of recognition signs into areas corresponding to a certain class of objects and to identify the relevance of the image being recognized to the corresponding class. The main approaches in image recognition theory are as follows: (1) algebraic, the main advantage of which is simple decisive rules; the main disadvantage of this approach is the unreliability of recognition, as it does not take into account uncontrolled factors that affect the recognition process; (2) geometric, which is characterized by its universality, simplicity, and ease of interpretation of the recognition algorithms; (3) statistical, which uses statistical characteristics of data analysis; (4) biological, which includes neural networks; (5) measurement; (6) the non-fuzzy one, which is created on the basis of algebraic approach, allows modelling the processes of recognition of images, which are naturally overlapping in the space of recognition signs, but it is not applied to optimization of parameters of the recognition system functioning; and (7) a game-theoretic approach, in which the decision-making rules are characterized by a high degree of complexity and a low degree of certainty of recognition. In practice, these approaches complement one another to improve the efficiency of image recognition. Image recognition methods can be roughly divided into two groups: intrinsic and extrinsic [5]. The study demonstrates the features of each group and the methods that belong to each group and identifies the quality characteristics of these methods and their disadvantages. There are several main tasks involved in image recognition, including the following: input data; a selection of informative features; object recognition and classification; automatic classification; dynamic recognition; dynamic classification; forecasting.

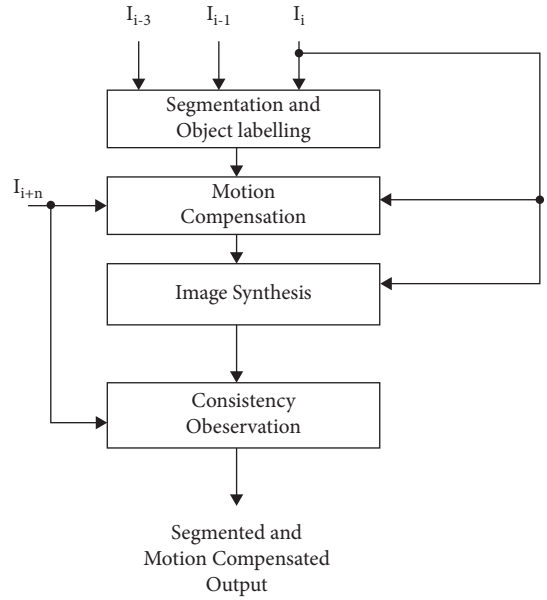

Figure 1: An algorithm for processing and analyzing images.

1.2. Research Results. As evidenced by the scientific sources on the problem of image recognition, the interest in solving more complex tasks of recognition of objects, due to automation, and the need for image communication processes in intelligent systems are growing every year. Therefore, improving the implementation of recognition of computer systems images is relevant. One of the promising directions of solving this problem is based on using piecewise neural networks and neurocomputers as the most progressive method in relation to the problems of image recognition classification [6]. At our time, a large number of neural network archetypes have been proposed for use in the recognition of objects. The analysis of the proposed solutions shows that none of the best-performing neuroscience solutions would be the best. The development of the theory of piecewise neural networks is associated with the names of neural networks which are useful for solving tasks in cases where a large amount of data has been accumulated, but there is no software to process and systematize it; the data available are spoiled, incomplete, or not systematized; and data are so different that it is difficult to see the links and patterns between them [1]. The artificial neural network (ANN) is a system of interconnected and mutually interconnected neurons based on relatively simple processors. Each ANN processor periodically receives signals from one processor and periodically sends signals to the other processors. Together, these simple processors integrated into the measure are able to solve complex tasks [7]. Neurons are most often located in the network by rank. Neurons of the first level are usually input. They receive data from outside and after their processing transfer impulses through synapses of neurons to the next level. Neurons on the other level (called adjacent, as it is indirectly connected to neither the input nor the output of the ANN) process the received impulses and transmit them to the neurons on the output level. As the neurons are mutated, each input-level processor

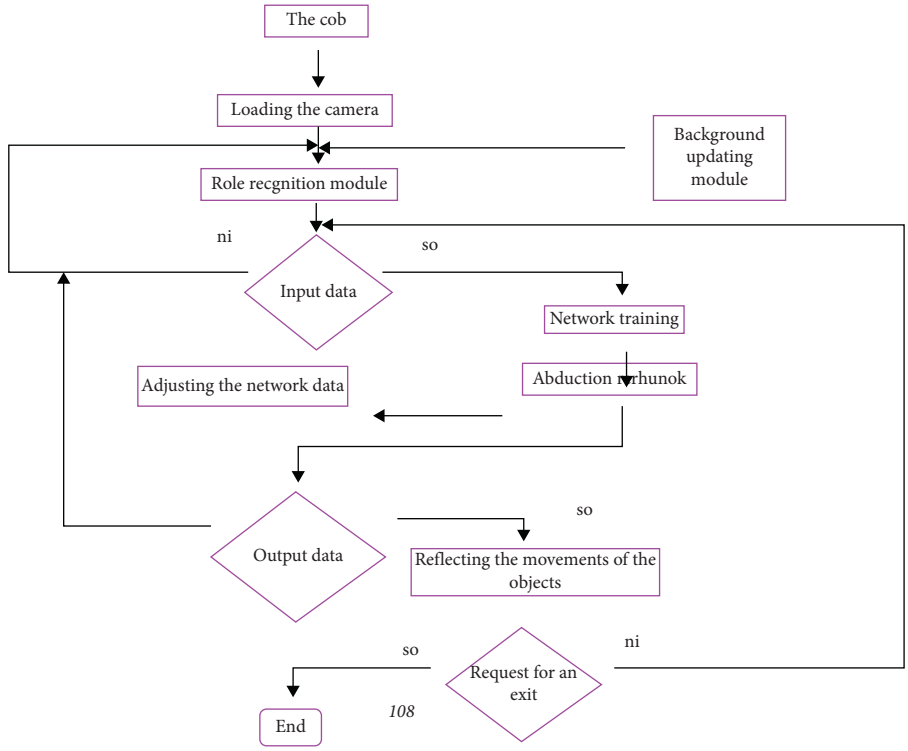

Figure 2: Image recognition algorithm.

is linked to several output-level processors, each of which in turn is linked to several output-level processors. This architecture is the simplest ANN, which is trainable and can find simple interconnections in the data. Figure 1 shows a schematic diagram of the complex image processing and analysis algorithm. This algorithm includes modules for controlling the calculation process. Thus, depending on the type of tasks solved, the structure of the complex algorithm can vary. When each stage of image processing and analysis is completed, the obtained information is fed to the control unit, which forms the plan for further procedures. Apart from the control unit, the database is stored in the processing system's memory, which contains the required data and various information processing procedures in accordance with accepted regulations [8].

1.3. Image Recognition Algorithm. Information support of the project of the automated system of video surveillance by means of a mathematical model of recognition of object movements can be represented in the form of a structural algorithm of information flows, which is presented in Figure 2. As a result, the network is self-organized, i.e., after the method is defined, modules based on different criteria matrixes are reconfigured in a cycle, making the scheme dynamic rather than static.

1.4. Findings and Prospects for Further Research. The development of video surveillance systems offers new possibilities not only for the detection of offenses but also, and more importantly, for their prevention. The capabilities of modern systems are also used for intelligent analysis of the video stream received. At present, there are a lot of different algorithms for image recognition. Each of them was created for a particular type of image, and for its subsequent use in the application of programming, we need to choose the most optimal method in terms of the specific task and improve it in specific realities. Our next task is to develop a software maintenance algorithm for video surveillance with the help of the runway recognition system.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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