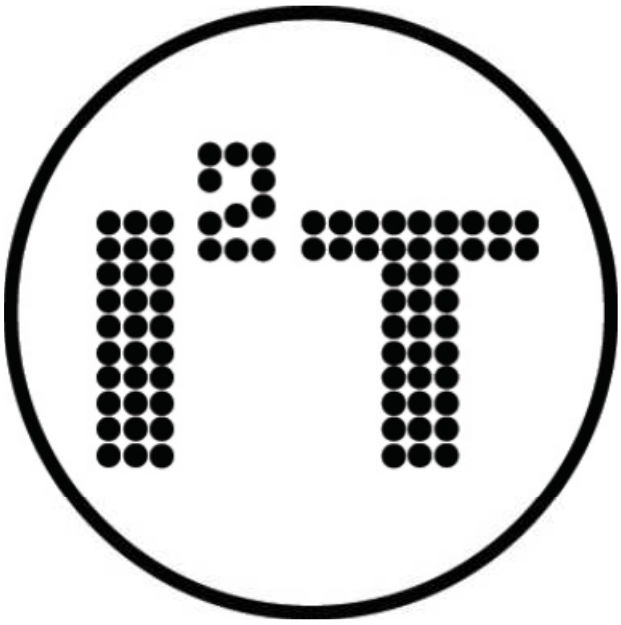
International Scientific – Practical Conference «INNOVATIVE INFORMATION TECHNOLOGIES»



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The materials of The Third International Scientific – Practical Conference is presented below. The Conference reflects the modern state of innovation in education, science, industry and social-economic sphere, from the standpoint of introducing new information technologies.

Digest of Conference materials is presented in 3 parts. It is interesting for a wide range of researchers, teachers, graduate students and professionals in the field of innovation and information technologies.

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INFORMATION PROCESSING METHODS IN VISUAL SENSOR NETWORKS

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In this paper we discuss information processing methods in visual sensor networks, analyze methods of increasing energy efficiency of visual sensor networks, associated with image processing on the end devices, propose new method, and review problems which should be research.

Keywords: visual sensor networks, image processing, energy efficiency

INTRODUCTION

Camera sensor network (wireless image sensor network, visual sensor network, smart cameras network) – is a wireless sensor network, where small low-power cameras are used as the main sensor in a system. There are a lot of limitations in such networks, these are computational power, bandwidth, energy resources. The main goal of deployment camera network is remote acquiring of information about surveillance objects and its transmission to the central node of a system for a long time.

Since images size is much more than scalar data size, acquired from temperature or humidity sensors in usual sensor networks and it has limited resources, then the key problem in camera sensor networks is the energy efficiency.

The aim of our work is to increase energy efficiency of wireless camera sensor networks with autonomous power sources. For this purpose is necessary to research information processing methods in such networks.

In this paper we discuss applications of camera sensor networks, information processing methods, analyze methods of energy efficiency increasing of camera sensor networks associated with image processing on the end devices, and propose new method.

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IMAGE PROCESSING IN VISUAL SENSOR NETWORKS

The main task of visual sensor network is remote distributed monitoring, using small low-power cameras [1,2,3,4,5]. We can determine three types of applications with respect to the desired end-user information in visual sensor networks:

- applications that require to transmit images;
- applications that images transfer are not required and necessary information contained in the images;
- mixed type of applications, when the information contained in the images, and transfer images themselves are necessary.

The main part of the applications refers to the second type as the receipt and transmission of images is not the aim of a system deployment. Image is only an intermediate form of information representation, needed for its collection by the end-device, equipped with a camera. Examples of such applications are: monitoring of intruder detection, monitoring of plant diseases, tracking objects, monitoring of rare species of birds and animals.

In the monitoring system can determine two principles of information processing:

1) centralized, when all information, obtained by end-nodes of the system, is transmitted to the central user-node which spends its further processing.

2) distributed, when information is processed by end-nodes.

Today photo and video surveillance systems built on centralized information processing method, when the cameras, distributed in the district surveillance, are obtain images and sent them to the user in the control center, where the images are processed, reproduced and stored. Because the amount of transmitted data is large, such networks have high bandwidth requirements.

In [6] the authors identify levels of intelligent video monitoring. Under the intelligent video monitoring, authors mean any surveillance solution, in which video processing performs directly on the camera-node and thus, reduces bandwidth requirements.

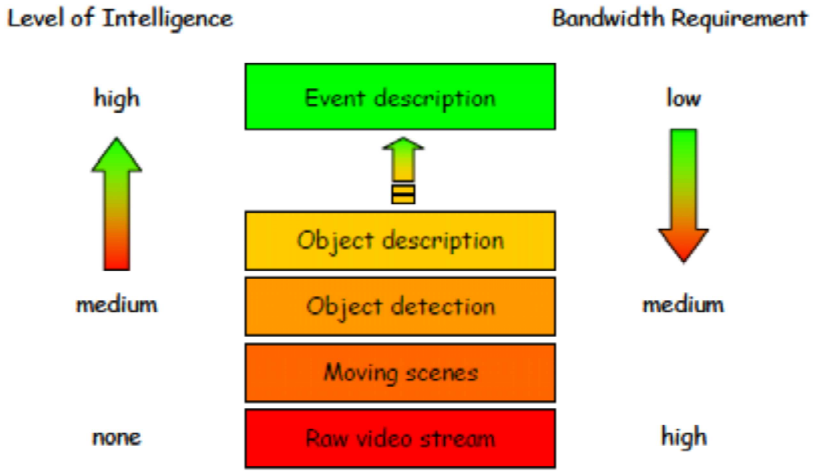

Figure 1. Intelligence surveillance levels

There is no intelligence of a network in existing video monitoring systems (Figure 1). In the video monitoring systems, where image processing is performed on the end devices, we can highlight four levels of intelligence:

1) At the first level, the camera nodes use a motion detection scheme such that only moving scenes are streamed to the surveillance center.

2) At a second level, the camera nodes can perform object detection and classification such that only moving scenes containing persons or more general objects of interest are forwarded.

3) At the third level, the smart camera nodes can collaborate to identify objects and only transmit their textual description along with a snapshot.

4) At the fourth level, a network of smart cameras can possibly just notify the surveillance center in case of events of interest by providing a hybrid textual/visual or fully textual description of the event.

Thus, with increasing levels of intelligence, when image processing performs on end-devices, decrease bandwidth requirements, since transmits less data, however, increase demands to the computing resources of the end-nodes, producing data processing. Since end-devices are autonomous, then energy resources are extremely limited and its effective using is the main topic of research many authors.

Consider the factors affecting energy networks: nodes hardware characteristics of the network, the frequency of data collection and transmission, which depends on the application, protocols of physical and link layers, network architecture, which determines the number of device levels, network topology, the routing protocol, as well as the total amount of transmission data. The efficiency of the network mainly determined by the amount received/transmitted information with respect to energy costs. To increase energy efficiency of a network is necessary to maximize the amount of useful information, transmitted over the network, and minimize the total energy consumption of network nodes.

Next, we analyze some methods, associated with data processing in visual sensor networks.

Image processing methods for the end devices are:

a) using of intraframe compression algorithms.

All compression algorithms can be divided into two categories: lossless (RLE, LZW, etc.) and lossy (JPEG, JPEG 2000, fractal compression algorithm, etc.). Lossy compression algorithms widespread as they provide a greater degree of compression than lossless algorithms, despite the fact that image quality is reduced.

In [7] authors studied the question of balance between the computational costs on the side of the camera-node and low-power transmission costs of images over the network. Authors review the application where camera takes metering from a counter. Before transmitting images, the authors conduct its preprocessing, performing downsampling.

b) image preprocessing at the node (background subtraction [8], motion detection [9], for example, based on pixel differences among frames, binarization, edge detection, etc.). Thus, the total amount of information is decreasing.

c) object recognition on the images on the end-nodes.

Proposed method can refer to distributed method of information analysis. It assumes the implementation of the object recognition process on the side of the end-nodes. Analysis results are transmitted to the other devices of a network. This should allow to significantly reduce the amount of transmission data over the network, their volume is becoming comparable to the volume of data using temperature, pressure, light sensors.

There is a range of problems which should be investigated in the development of the method.

First, to determine what kind of image processing algorithms and pattern recognition can be used for low-power devices with limited resources.

Second, to identify groups of objects that can be effectively recognized locally on the end-devices. If an object is more complex, then more time is required for its recognition, and respectively more energy resources are consumed. But is not the fact also that if the frequency

of the processor is lower, then the less energy will be spent in the computation. It's not the fact that the less energy will be spent in the computation if the frequency of the processor is lower.

Third, identify what kind of characteristics (resolution, color depth, etc.) should be taken images, which the distance to the surveillance object should be to be able to recognize it.

Fourth, to determine how the network devices should interact with each other (network algorithm).

These and other questions should be investigated in the development of method that will increase energy efficiency of the visual sensor networks.

CONCLUSION

Object recognition on the side of low-power end-devices can be used as a method of increasing the energy efficiency of the visual sensor networks with independent power sources. In the article we discuss some methods of image processing on the camera-nodes, define the tasks for further study, it is shown that to increase the efficiency of the network should improve its intelligence, that is, to conduct the information processing on end-devices. The proposed method can be implemented in applications, which are not required images transmission from the end-nodes to the central node.

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