AENSI Journals
Advances in Environmental Biology
ISSN-1995-0756 EISSN-1998-1066
Journal home page: http://www.aensiweb.com/AEB/

Implementation of Distributed Video Coding in Multimedia Wireless Sensor Networks

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ARTICLE INFO
Article history:
Received 11 June 2014
Received in revised form 21 September 2014
Accepted 25 November 2014
Available online 29 December 2014

Key words:
sensor networks, wireless networks, coding, video distribution, mosaicking

ABSTRACT
In recent years, there have been various networks for information transfer. The multimedia information such as video includes high amount of volume. This high-volume requires a broadband, high electric and computing power for processing and data transmission that is not possible in many networks. For example, multimedia wireless sensor networks can be named in this regard which have serious limitations in their resources such as memory, bandwidth and power consumption. So in this paper an algorithm is presented that utilizes its natural affinity to video data transfer in wireless sensor networks, and using distributed video coding to reduce the volume of information sent in the network that will lead to increased longevity of the network.

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To Cite This Article: Nayereh Zaghari, Majid Abdoos, Somayeh Mohammadi., Implementation of distributed video coding in multimedia wireless sensor Networks. ***Adv. Environ. Biol., 8(21),*** *780-785, 2014*

INTRODUCTION

Today, information and communication technology has made it possible to exchange knowledge in various forms. One of the most important of these templates is the exchange of information in the form of a video. Since video images contain large volumes of data, during recent decades, experts have always tried to reduce the volume of video data with minimum quality loss. So far, a variety of standards in the field of video compression has been provided.

Among these standards, MPEG algorithm can be noted in this regard that has been registered by ISO Committee. Also some standards such as H.261 and H.263 that have been provided by ITU-T committees. These standards reduce the data volume significantly. However, new solutions can be used to reduce still further reduction of the data volume. In addition, there are some applications in which current standards cannot be employed and other techniques are needed to encode the video.

One of these applications is video transition on multimedia wireless sensor networks [1]. Multimedia wireless sensor networks are new class of wireless sensor network which have high potential in solving issues related to interaction with real world in industry, environment, medical and security applications [2]. Meeting the extreme and pre-defined multimedia data quality requirements on a network of low-power nodes energy in terms of energy, processing capability and storage capacity has created many challenges facing the researchers.

In this sense, production and transition of video data on WMSNs has the most challenges compared to other multimedia data. Because ,on the one hand, it has a heavy processing , a high bit rate in encoder section and strict QOS requirements and on the other hand, there are some limitations resulting from low-power nodes and wireless flawed channel that makes it almost impossible to use the traditional methods of video coding like MPEG with H .26x for these networks. Video encoding method is one of the most suitable options using in multimedia wireless sensor networks due to its less computational complexity [3].

In addition, coding of separate frames in this encoder, which is resulted from its particular design, makes it is possible to have multiple view from scenes without the need for communication between nodes in the case when the network is condensed.This collection of features is not only able to make those ideas related to WMSNs more possible, but also provides many other innovative applications that are impossible for WMSNs using traditional methods of video coding [4].

The main purpose of a wireless multimedia sensor networks can be viewed as a phenomenon with the reliability and high performance that necessary actions are done based on this observation.

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One of the main applications for multimedia data transmission on wireless sensor networks is, for example, tracking and identifying the enemy's talent in a war environment or monitoring the urban environments [1].

With regard to what have stated above, in this article we study the implementation of distributed video coding in multimedia wireless sensor networks, and an algorithm is provided for taking advantage of dependency. So with implementation of distributed video coding in wireless sensor networks, the volume of information sent in the network for eye measurements is reduced.

*2. The structure of distributed video coding***:**

In recent years, distributed video encoding methods have been introduced. The reason is that the traditional methods are not able to meet the needs of those networks that are structurally different from former networks [5].

Today, with advent of some networks such as multimedia wireless sensor networks , handheld digital web cameras, cell phones with multimedia facilities and Personal Digital Assistant, a new video data transition over wireless channels have come into existence.

In these systems, the network has a large number of transmitter nodes. These transmitters, in which a video encoder is placed, send their information to a receiver that usually is a Base Station. The central station that has a video encoder is able to monitor the observation range based on received information [6]. The important thing to consider in the design of such a system is having the conditions of the transmitter and receiver nodes and also the communication channel.

The most important of these conditions are limitation of the receiver nodes' computational and electric power, the high rate of errors in communication channel and low bandwidth [7]. In addition, because of the large number of nodes, the bands of receiver should be designed in such a way that their price be at the lowest possible value. For these reasons the classical methods of video encoding may not be used in this networks.

The proposed method to compress video data in these networks is DVC encoding which is based on Distributed Source Coding that almost meet all the needs of new networks[8]. In DVC encoding, each frame is encoded independently that not only makes the video tail more lasting, but also makes encoder independent from motion search in order to find the motion vectors [9].

In fact, in this encoder of decoders, there is not any motion compensation operation. The lack of this operation in the encoder of decoders leads to lighter encoders in terms of computational complexity, and it also reduces their consumption energy significantly . In addition, DVC- based encoding methods provide high compression. In fact, in these methods, the extraction of time correlation and also the remove of time redundancy are done in decoders. All these benefits are obtained at the expense of imposition of heavy conditions on receiver and its encoder that is placed on it. the encoder is obliged to search the time correlation of frequent frames in a video tail. In other words, DVC algorithms pass the computational complexity of the encoder of decoder to the decoder [9,10].

3. The multimedia wireless sensor network:

A sensor network consists of a large number of sensor nodes that are in a widely distributed environment to collect information from the environment. The location of sensor nodes is not already specified necessarily. The unique feature of sensors is indeed cooperation and correlation ability between sensor nodes. Each sensor node has a processor that first makes a series of basic and simple processing on the gained information and then transmit the half-processed data instead of transmitting the all raw data to center or to the node that is responsible for processing and concluding the data[11]. The main difference between wireless multimedia sensors from typical sensors is that the typical sensors measure the scalar quantities such as temperature, humidity, etc., but wireless multimedia sensors are equipped with the cameras that are able to film and photograph the environment[12].

4. The proposed algorithm:

Since in the sensor networks, the covered space of most video sensors are often shared with each other, in this algorithm we have provided a method that based on it, each camera sends part of its own image to decoder and is exempted from sending the part of its image that is sent to decoder by other key cameras. This action is done through formation of a main reference image by using mosaicking algorithm. That is to say, after sending the first frame by each camera, a mosaic image is formed by which the common parts sent by camera are specified , and then based on a specific mechanism, it is determined that what part of camera image belongs to that camera in order for the camera to send only that part of its image

Also in the decoder for each camera, that part of camera frame, which has been sent by other cameras, is decoded and then along with that part of frame, which has been sent by camera itself, will form the overall frame related to that camera that its accuracy will be very close to main camera. Thus we will see that by using the proposed algorithm, the volume of information sent by the camera in the network will be reduced to a very large extent, and as a result the lifetime of network will be increased accordingly. All steps of doing this algorithm are described as follows in detail:

4.1 formation of reference image by mosaicking process:

In the first step of the algorithm, all the cameras encode their first frames by using H.264 and then send them to the decoder. Then, by using the mosaicking algorithm, the general space of that section that is covered by cameras, is created.

The mosaicking process does it in five steps. First, it extracts feature points of all the images by using SIFT algorithm and then implements these feature points in each pair of images through an implementation technique like Cross Correlation or Nearest Neighbor [14]. Since this compliance is incorrect, at the next stage this incorrect compliance is deleted by a model of compliance feature matching and then using the correct compliance. Homographic matrix maps out the maximum feature in the first image compared to corresponding feature points of the second image . In final step of mosaicking process, using the homographic matrix, each image is transferred and then is placed in its reference image to final mosaic image to be built. Meanwhile, we store the coordinates of the four corners of each image attaching to the reference image relative to total scale. In addition, at this stage, prior to the placement of each image in the mosaic, a filter image is obtained for it in which the area contains a specified image in order to delete the effects of the rotation and scale change of the image by this filter at time of decoding. After applying the above five steps, the resulting mosaic image would be almost similar to the figure (1).

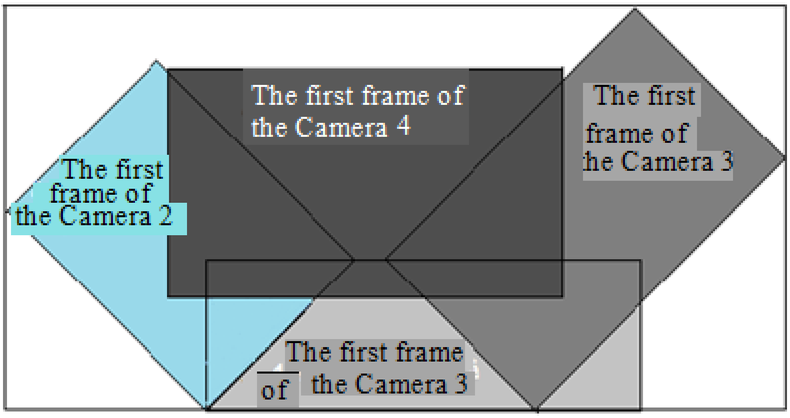

Fig. 1: Schematic picture of the output mosaicking algorithm.

4-2 Sending and decoding of information of the cameras:

In this step of the algorithm, first we offer a solution that after sending the second image to the next, each camera sends only that area of its image that is allocated to it(some parts of the image that will not be send by none of the cameras any more). For this reason, at first, through using the coordinates of each image in the reference image, those areas of the image related to each camera that has been provided only by that camera are allocated to that camera. For instance, the area allocated to the camera number 1 (Figure 1) which is an example of an image reference, up to this stage of the algorithm is presented in figure 2.

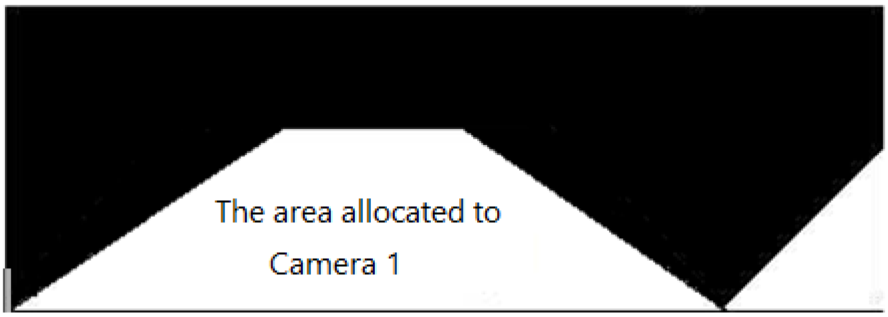

Fig. 2: The allocated area for camera number 1.

In the case of common areas that are provided by two or more cameras, we divide these areas among cameras so that the area of the dedicated area to cameras relative to total frame in entire network can be balanced. So in the next steps of sending that are done for the second frames to the next, each camera in only responsible for sending its allocated part of frame.

Now in order to inform each camera of its allocated area, we create a mask for each camera and then multiply it by the counter homographic matrix and reference image in order for the mask to be converted to the same scale of the main frame. Then, we divide the mask into 8 × 8 blocks and send it to that camera based on the block.

The camera, before sending any of its frame, multiplies it by this mask and then sends it. In this way, only the allocated blocks to the camera are sent toward the decoder. Figure 3 shows an example of created mask for camera number 1 in figure 1. Each camera in addition to sending the allocated blocks, produces a number of bits and sends them toward the decoder. For the second frame to next, which cameras send only allocated areas, , the only thing that the decoder does after receiving each frame from camera for the building the mosaic image is that it just multiply the frame by the related homographic matrix and puts it in the reference frame. Thus it is not necessary to do all the stages of the mosaicking process.

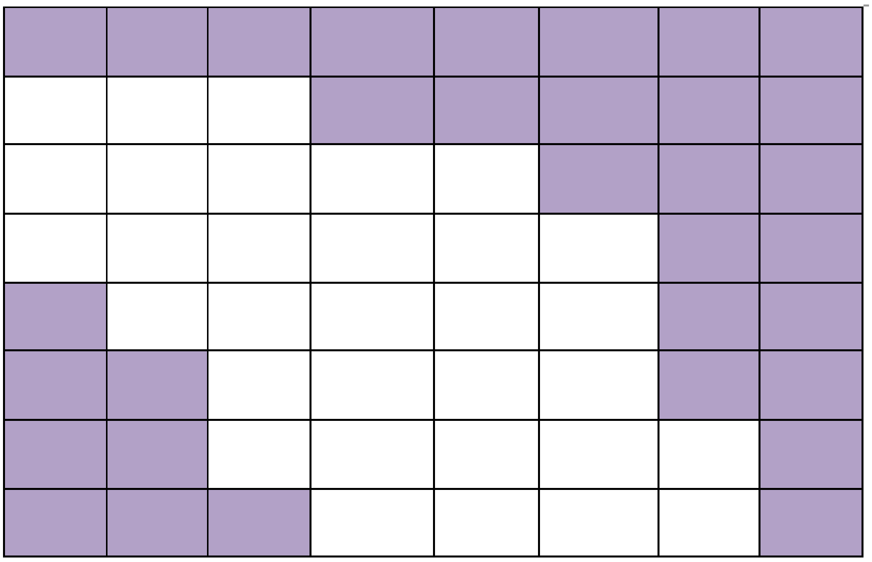

Fig. 3: Estimated transmission mask for camera 2.

So far, the main subject matter was the transmission of information and formation of the mosaic image. Now, we want to talk about reception and information decoding. In decoder, each obtained mosaic is used as a tool for compression to extract the information of every camera, specially those parts of the information of each camera that have not been sent by it. That is to say, unsubmitted information of each camera is calculated by information sent from other cameras that are shared by that. To reach this goal, the following steps are presented.

First, the coordinates of the image related to each camera, which is stored in the fifth step of the mosaicking process, are extracted and then the extracted area for each camera ,which is specific to that camera, is multiplied by the filter that has been built in final step of mosaicking in order for the image to return to its initial state, if the image is rotated or changed during being put in mosaicking.

Now the resulted item which has been obtained from previous step is multiplied by the counter of the homographic matrix related to this frame as well as reference frame to obtain the main frame of the camera.

Since some parts of the frame have been sent by the given camera and some other parts by other key cameras, in this step, we separate that part of the frame that the camera is exempt from its sending and give it as side information along with produced bits by encoder to the decoder.

After decoding, we add this area to the main parts and then form the decoded frame of this camera which its accuracy is very close to that of actual camera. We do it for all the cameras.

Thus we see in this algorithm that every camera is responsible for sending just part of its frame. With this reduction in amount of information sent, which will lead to reduction in energy consumption, this algorithm will be able to significantly increase the longevity of sensor network and solve the energy limitation of the sensors, in spite of the lack of need for complex calculations. The result of the simulation of this algorithm ,which will be presented in the next section, will show the obtained progress obviously. The reason is the division of the transmission mask into 64 blocks. Another reason is that in the area where the number of block white pixels are less than certain number(10 % of all the pixles of that block), the camera is exempted from sending that block.

As it was mentioned before, by adding the number of transmission mask blocks, the quality of the side information can be increased; however, this action will lead to raise of the transmission rate of each node.

Figure (5) obviously show that the amount of information transmission is about for average between 40 to 50 percent for every camera that has had a significant reduction compared to transmission of 100 percent of information, and so by reducing the information sent, lifetime of the network will increase considerably.

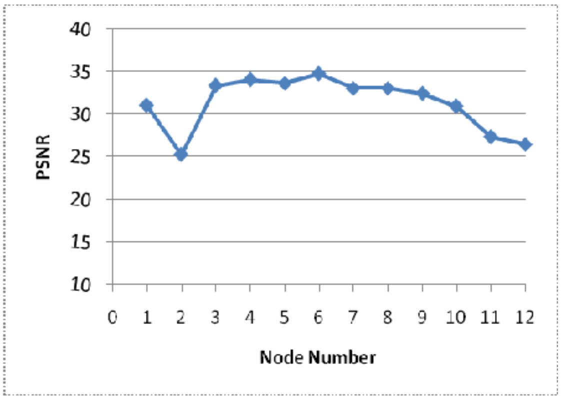

Fig. 4: Quality of the obtained side information for each video sensor.

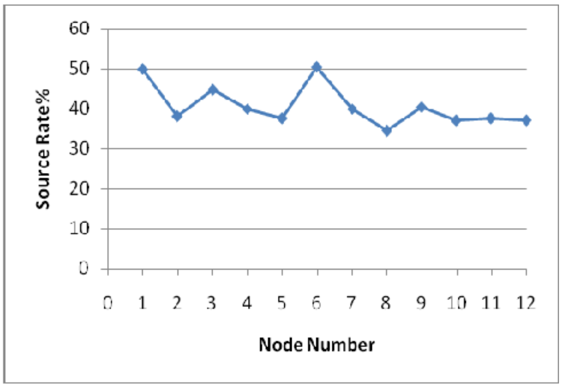

Fig. 5: Information rate sent by each video sensor.

Conclusion:

In this article with respect to the subject matter and purpose of the research, we have provided the algorithm that with consideration of the spatial and temporal relationship between information sent in and WSNs reduces the volume of data and thus leads to reducing the energy consumption. with distributed video coding compliance in multimedia wireless sensor networks, we've provided a mechanism upon which every camera instead of posting its images, sends only some part of each frame ; in this way the quality of the information received by decoder will not be prejudice. Video encoding methods that are of acceptable compression and meet the conditions of our given network, is algorithms of inter encoding. Simulation results show the reduction in volume of information sent and maintenance of the quality of the information.

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