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EFFICIENT SEMANTIC PROCESSING FOR WIRELESS SENSOR NETWORK IN SURVEILLANCE SYSTEM

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Abstract:

Surveillance system is used for the careful observation of people or group in any particular public area or an organization. The word 'surveillance' refers to 'watching over' which means close watching of specific area. In the previous work an automated hierarchical semantic processing architecture is implemented for surveillance system by using multimodal sensor information that is both audio and video. The system learns the predefined and observed behavior to detect any abnormal situation. Due to bad weather conditions or low processing capabilities the pre- processing of low level symbols (LLSs) can lead to deliver noisy and inefficient data. In this paper the pre-processing of symbols with fully efficient noise filters such as Fuzzy Impulse noise Detection and Reduction Method (FIDRM) is proposed. The results are achieved through simulation and mathematical analysis.

Key Words: Surveillance System, Multimodal Sensor Information, Inefficient Data, Pre-Processing & FIDRM

Introduction:

Wireless Sensor Network (WSNs) is a new research technology in distributed computing environment. It is a distributed network consists of several multifunctional sensor nodes depending upon the deployment environment and applications. A base station or sink node uses internet to connect a sensor network with users (Figure 1). It has significant role in pervasive computing and supports variety of applications such as environmental monitoring, battlefield surveillance, industrial and consumer applications, habitat monitoring, smart homes, construction structures and so on. A WSN node has three main units they are sensing, data processing and communication unit which consists of memory, processor, transceiver and battery. In this work the surveillance application of WSN is mainly concentrated. Surveillance means watching over specific area now in general it is used as synonym for the word security. It keeps check on the area which is to be monitored and records information simultaneously.

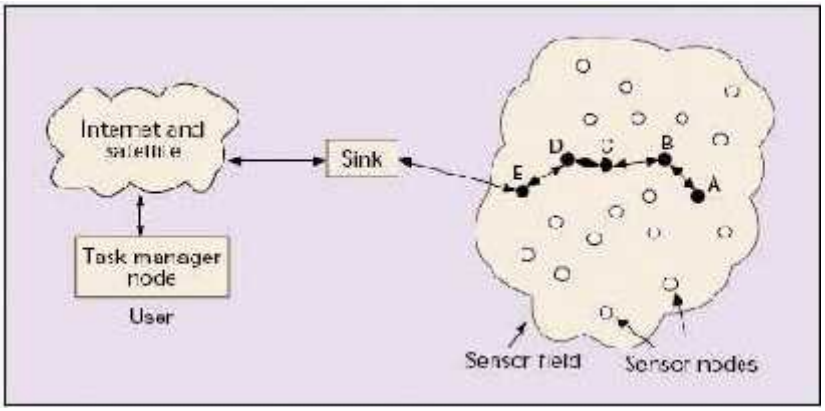

Figure 1: WSN Architecture

Some different types of surveillances available are computer, telephone, camera, biometric, social network analysis, data mining, identification, RFID, GPS etc. which uses different technologies. In earlier days surveillance system was

used in government organizations only but nowadays used by many private companies and organization also. It monitors and prevents the dangerous activity, provides security to the employee, property and system of the organization. The main advantage of surveillance system is social security which is achieved by using video surveillance technologies as digital video processing, wireless transmission. To detect environment changes and abnormal motions caused by intruders, surveillance system uses some intrusion detection technologies. Such type of system is mainly based on video, audio and radar devices. Closed-Circuit Television (CCTV) system is one of the widely used technologies for video surveillance system. If there is a bad weather condition, crowded area or quickly changing actions by person in crowd, the monitoring of particular environment will become difficult for the surveillance system. In the above situations, due to low processing capabilities the system has to relearn the environment number of times to get efficient information.

In this paper to overcome the above problem an efficient semantic processing for WSN in surveillance system is proposed. In the previous approach hierarchical semantic architecture with eight layers is implemented to detect any dangerous situation and give the notification to the user or the security person in charge. It is implemented with the embedded network where nodes consisting of cameras and microphones for sensing video and audio unit respectively which is called as Smart Embedded Network of Sensing Entities (SENSE). These nodes automatically process the sensed information and communicate with the neighboring nodes in order to detect abnormal situation, events or behavior. In the eight layer architecture the lower layers are used to process Low Level Symbols (LLSs) and these symbols are further processed by upper layers to infer High Level Symbols (HLSs). These HLSs are exchanged between neighbor nodes to find a global view of observed environment then the detected abnormal situation is reported to the security staff. While preprocessing the observed LLSs some noisy or inefficient data may be delivered due to limited processing capabilities. In order to remove noise from monitored low level symbols an efficient filter namely Fuzzy Impulse Noise Detection and Reduction Method (FIDRM) is used. This will remove impulse noise and other type of noise such as salt & pepper noise, speckle noise etc

Related Works:

In recent days the public areas are becoming full of threats like terrorism, accidents, robbery, murdering, kidnapping etc. To provide security all around the time for people in common areas some effective observation systems are needed. In [1] an idea of novel framework approach is presented with multimodal sensor information for valuable information. A hierarchical semantic processing architecture for surveillance system is proposed. In this predefined behavior are identified and normal behavior is learned, if any deviation from learned behavior means some notification is given to the staff. The advantage is that the notification should be understandable even for the person without any special training. This approach is described to be deployed with network of SENSE nodes. They suggested that the first application will be the airport, the need of airport staffs is considered to classify the abnormal situation and alarm detection. The SENSE node is a smart sensor which provides extra functions to generate correct representation of sensed quantity.

The low level video processing algorithms in the SENSE node are developed in [2] for distributed intelligent sensor network in surveillance application. It constitutes of smart node, the detail of embedded architecture along with video processing algorithms is described here. It has been implemented using two DSP

processors for video processing with FPGA for image capture and to dispatch them to DSP. The selected algorithms are for segmentation, tracking, low level classification of objects and adapting of background scenes to changes in lightning conditions, for these algorithms both theoretical and experimental results are evaluated. The detected objects in each frame are classified into three main categories such as luggage, person and group. Using XML the obtained results are communicated to upper levels. In the first stage the algorithms are tested under Matlab environment and for practical results embedded in DSP processors. The main challenge of sensor networks in surveillance system is merging of observed information from individual nodes to a common semantic representation of environment which is addressed in [3]. Here an approach by correlating the local information which is learned in low level at each sensing unit that is audio and video to infer a global view is presented. This system will learn predefined events and usual events to detect the threats in surveillance environment. The objective here is to create common global representation which is shared between nodes by wireless communication; with step by step processing the low level information is enriched and further processed by high level layers. The precise calibration of individual node is reduced in this approach. For preprocessing the parameters of low level symbols an algorithm called Gaussian mixture models [4] is used. The parameters are size, speed and direction of movement of target (angle). The variants of this algorithm are used to analyze different parameters such as a split and merge algorithm for Gaussian mixture model which is used to determine the angle of target. The angle set for each pixel cluster is determined by split and merge algorithm, the aim is to build statistical model of the angle by analyzing the moving objects in each frames of video and this model is used to detect the abnormal behavior of objects. The angle data in each frame is analyzed to form a statistical model. Further the tracking of interacting objects in any surveillance monitoring system is one of the major issues, traditionally multiple interacting targets are tracked by multiple single object tracking filters which prone to failure exactly when interaction occurs therefore a particle filter namely Markov Chain Monte Carlo (MCMC) [5] is specifically designed to track the interacting objects. It is used to track the preprocessed symbols in the tracking layer. In each step Markov Random Field (MRF) [6] is used to improve the tracking while targets are interacting. Here the more efficient tracking is done by the sampling of Markov Chain Monte Carlo is called as MCMC-MRF approach. This MCMC sampling removes the exponential complexity from joint particle filters. The resulting filter handles the complicated interactions very effectively when targets move close to each other.

During the feature extraction step of monitored area in surveillance system may lead to give noisy or unstable data because of low processing capabilities in bad weather conditions or number of persons in a scene. Due to this some efficient filters are required to be used in the preprocessing of extracted low level symbols to remove noise and give clear data to audio and video unit sensor. An algorithm Fuzzy Impulse Noise Detection and Reduction Method (FIDRM) [7] is developed to remove all kinds of noise from extracted feature.

Fuzzy Impulse Noise Detection and Reduction Method (FIDRM):

Noise in image is measured by the amount of pixels which are corrupted. Impulse noise is defined as the noise caused by noisy sensors, errors in digital cameras. When some pixel value set to zero and maximum is called as salt and pepper noise which is most common form of impulse noise. FIDRM [7] is a new, very

faster and efficient filter to detect and reduce the impulse noise from images. It consists of two steps they are

- ✓ an impulse noise detection step
- ✓ a reduction step

This also preserves the edge sharpness. The fuzzy rules are used in detection step to determine whether the pixel is corrupted with impulse noise or not. It is mainly based on fuzzy gradient values that constructs fuzzy set namely impulse noise. When the noise is detected some parameters are decided to move into filtering or reduction step where fuzzy filtering technique is mainly concentrated on exact noisy pixels only. In this step membership function is used to represent the fuzzy set. All types of impulse noise such as very low and high can be removed by this technique. The main advantage of FIDRM is that it keeps the noise free pixels unchanged while processing the noisy pixels and it is easy to implement.

Node Architecture:

The smart sensors will be used to monitor the surveillance environment, in order to capture both video and audio the node consists (Figure 2) of intelligent cameras and microphone array. The sensor nodes will be identical which act autonomously and mounted at fixed location. It interprets the gathered information. The global view is created by fusing the nodes own information with neighboring nodes information. These nodes are capable of processing its own information and communicate to other nodes which build a shared understanding of objects and events and their relation to the environment.

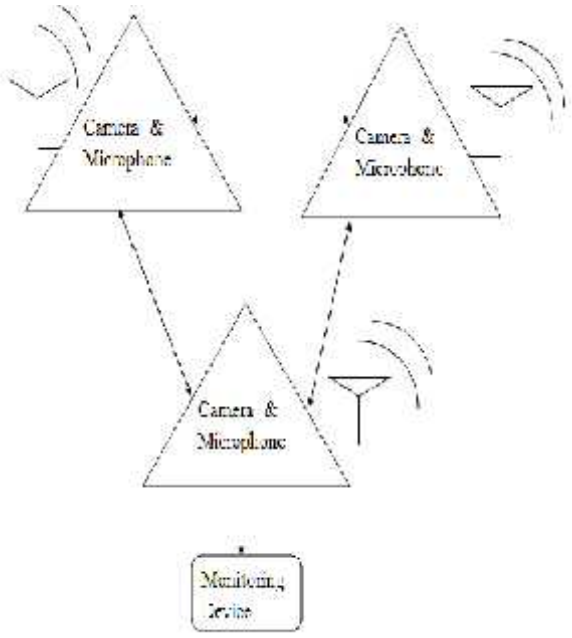

Figure 2: Node Architecture

System Architecture:

In this architecture (Figure 3) the monitored environment of surveillance system is considered as a wireless sensor network as smart sensors will be used for monitoring. When sensor captures the video from environment is depicted as video selection. Then the preprocessing unit comes where the extracted low level symbols from video is preprocessed to get noise free data. It includes four parts they are

- ✓ Frame Preprocessing

- ✓ Noisy Video
- ✓ Noise Metrics
- ✓ FIDRM

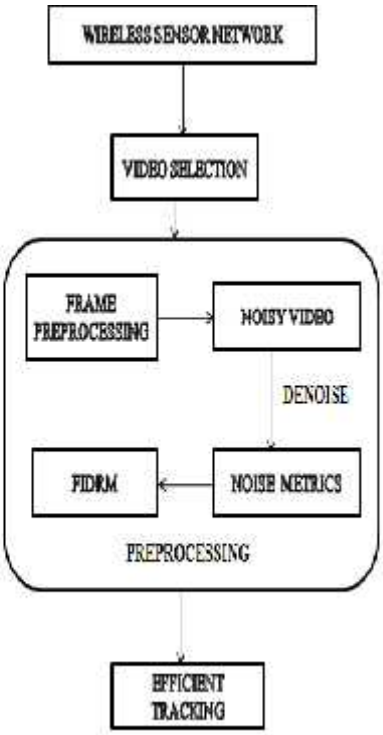

Figure 3: System Architecture

The selected video will be converted to number of frames depending on the number of pixels per second in the video. Some noise values are added to the video such as the selected video will contain noisy data. Then the noisy video will be denoised and analyzed with some noise metrics. To further recover the noisy video an efficient filter will be used such as Fuzzy Impulse Noise Detection and Reduction Method (FIRDM). The output of this filter is further used by tracking layer so that efficient tracking can be performed to track the sensed low level symbols of target. With noise free low level symbols the high level symbols are effectively inferred.

Simulation:

The simulation results will be achieved through Matlab. FIDRM technique used to pre-process the low level symbols to remove all the noise from captured video and make the further process efficient.

Conclusion:

In this paper efficient pre-processing is performed with noise filter such as FIDRM technique. It will remove all types of impulse noise from the captured video. In future this can be implemented in any real time surveillance system environment for monitoring it effectively with the usage of SENSE nodes.

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