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Smart Surveillance Analysis System Using Hadoop

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Abstract: Security and time play very important role in everyone's life. So it is required to develop a system which will make an individual feel protected. In case if any changes are detected then it can be analysed in a minimum time. Up to some extent, environmental changes are also detected. The first task of multi camera surveillance is Automation object detection analysis.Changes in the CCTV recording are detected using OpenCV and they are represented by using particular colors. On single machine it will take ample of time to analyse the CCTV video recording, this drawback is overcome by using Hadoop. Hadoop has a feature of centralized server processing and distributed processing. Analysis is done using algorithms. Color histogram, Mean square difference and SSIM index are the algorithms used for frame comparison. An algorithm with the accurate result is preferred. Experimental results show a reduction in analysis time.

Keywords: Image Processing, Video Analysis, Scene Change Detection, Hadoop, MapReduce, OpenCV Library.

I. INTRODUCTION

Image processing is the process in which input is given in the format of image or video and output is the image or may be set of parameters related to that image. Surveillance involves closely observing data and monitoring of data. Surveillance cameras are video cameras used for the purpose of observing an area. When the light's color or direction changes, it is difficult to trace the object or detect the object. Hence to avoid this we uses gray scale method in which RGB coordinates converted into the gray scale co-ordinates. This system overcomes the drawback of the previous traditional system.

In this system first video is recorded. Using OpenCV we get access to read the video in java. Then First frame is compared with the last frame using algorithms. In that we uses algorithms namely color histogram, mean square difference and SSIM index .Color histogram is used for detection purpose and remaining two are used for enhancement of the quality of image. If any scene change is detected video is stored on server for further analysis. To reduce the analysis time we used Hadoop for further processing. Mapreduce is a programming model for large data processing. In this input data is divided into the chunks and those chunks are processed parallel. Input given to the mapper is in the form of key-value pair. Intermediate output of the mapper is given as input to the reducer which produces output in the form of key value pair. This output is merged together and provide final output.

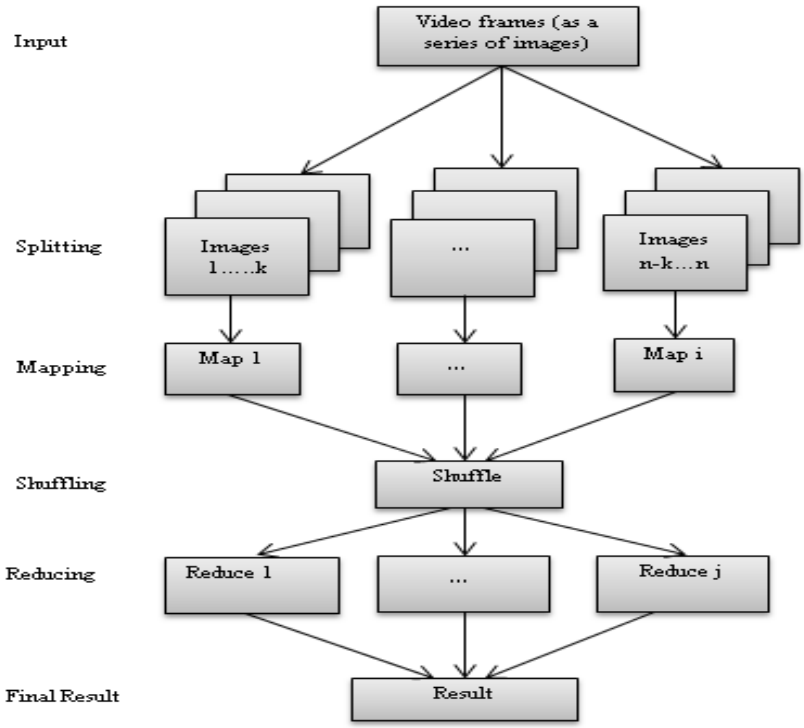

Fig.1.Image Processing Over Hadoop

II. LITERATURE SURVEY

A. New Object Detection, Tracking and Recognition Approaches for Video Surveillance Over Camera Network.(2015)

In this paper, they present new approaches for object detection and tracking in camera network which improves results than conventional method. For detection they used color based MS segmentation which improves segmentation of objects. The segmented object tracked by BKF-SGM_IMS which avoids exponential complexities with good performance and low arithmetic complexity. The performance of both non-training and training based object recognition algorithms can be improved by this new approach. [1]

B .Counting Occurrences of Textual Words in Lecture Video Frames using Apache Hadoop Framework.(2015)
In this paper, textual words are recognized and occurrence of each textual word is counted with the help of mapper and reducer function in which mapper function recognized words using TESSERACT recognizer and reducer uses this information to return no. of words present in video. TESSERACT is an optical character recognition engine for various operating systems. It is free software, released under the Apache License GUI is not present in TESSERACT and is run from the command-line interface. [2]

C. Study on Surveillance Video Abstraction Techniques.(2015)
In this paper, video abstraction provides efficient and fast browsing of video contents by using four techniques such as feature based, event based, cluster based and trajectory based.[3]

D. Image Processing Techniques for Object Tracking in Video Surveillance- A Survey.(2015)
A video tracking is the process of locating a moving object or multiple objects over a time using camera. In this paper, how objects can be represented with important feature descriptor is explained and also tracking process is explained from detection, recognition till object tracking types such as region based, active contour based and feature based with their positive and negative aspects. [4]
E. Content Searching of Surveillance System videos.(2015)
CBIR systems go through sets of stages starting from acquiring the new images, representing these images by extracting the image features, describing the key features and eventually computing the similarity distances to get the most relevant results responding to the query image. ICBIR an integrated CBIR Hadoop-Map Reduce based framework which is split into both offline and online phases. Visual statements are built using the extracted interest points SIFTs. [5]

III. EXISTING WORK

CCTV(Closed Circuit Television) are used for surveillance and security for monitoring, spying, or safety purposes.
During the last decades as the technology has improved functioning of a CCTV camera is also been improved.
They are used in almost every bank, casino, mall, large and smaller departmental store , offices, private properties and homes etc.

But the disadvantage of this is that if any theft or malicious activity occurs then we have to go through the whole video to detect where the exact change has been occurred.
This process of verifying the whole video in order to detect the intrusion is very time consuming and hectic.
Our implemented system overcomes this disadvantage with faster analyzing and processing using Hadoop to detect change and environmental changes are also detected upto some extent.

IV. TECHNOLOGY USED

A. Hadoop

Hadoop is the open source framework released under the license of apache. It is written in java. It is not used for storage purpose. But it is used for processing purpose. Hadoop architecture consists of four parts .They are Hadoop common, Hadoop YARN, HDFS, and Mapreduce.

a) Hadoop Mapreduce

It is a software framework .It is generally used for processing large amount of data which is present in the large clusters. Two different tasks are performed by mapreduce.
Map task: it is a first task which takes large dataset and breaks it into key value pair.
Reduce task: output of the first step given as input to the reducer. In this step output is merged to reduce
Datasets. This operation always performed after map task.
Job tracker and task tracker are the two components which are present in the mapreduce.
Job tracker also known as a master and task tracker also known as slave. Job tracker assigns tasks to the task tracker and each task tracker node is monitor by job tracker. If any jobs fail then task tracker gives the notification to the job tracker.

b) HDFS (Hadoop Distributed File System)

There are many file system on which Hadoop works. But common file system used by Hadoop is the Hadoop distributed file system.
Master slave architecture is used in HDFS which consist of name node and data node.
Actual data is stored on data node and file system metadata managed by the name node.

c) Hadoop YARN (Yet Another Resource Negotiator)

It is used to allocate resources. It separate resource management and processing components. Resource manager (master) and node manager (slave) are the two components of the yarn. Master knows that where the slaves are located. It offers some resources to the cluster.

B. OpenCV:

It is an open source vision library in C/C++.It is an optimized and intended for real-time application. It is an OS/hardware/window manager independent. Generic video/image loading, saving and acquisition. It supports both low and high API. It provides interface to Intel's Integrated Performance Primitive with processor specific optimization. It consists of machine learning library.

V. IMPLEMENTATION AND DISCUSSION

A. Advantages

1. System gives better results than previously implemented system.
2. Reduction in processing time due to Hadoop.
3. Cost required is low.
4. Environmental changes up to certain limits are also detected.
5. System is more reliable, secure and transparent to use.

B. Disadvantages

1. Server machine is have to be kept on all the time.
2. It is a indoor system.

C. Modules

1) Video Recording: Recording of a video is carried out by using a CCTV camera and that is a video used for a further processing.

2) Frame Extraction: Recorded video is divided into number of images called as frames and frame extraction is done.

3) Analysis of video: Analysis of a CCTV video is takes place by working on frames which are divided in frame extraction. That frames are compared to detect the intrusion which is done by using an algorithm color histogram.

4) Processing using Hadoop: Hadoop is having a concept of mapreduce, by using mapreduce software framework CCTV video is splited into chunks and these chunks are processed separately and parallel . This results in reduction of processing time.

5) Parsing: The processed output using a mapreduce framework is in a text format which is stored on a server and downloaded later. The changes in a video are shown by using a green color and on a graph changes are shown by using a red color.

D. Algorithms

Formula for converting r, g, b co-ordinates into gray scale image is:

$$G(x, y) : 0.299 * Fr(x, y) + 0.587 * Fg(x, y) + 0.114 * Fb(x, y)$$

Where,

F : *Extracted frames*

$r, g, b : r, g, b$ *co – ordinates related to corresponding frame*

1) Mean Square Difference:

In this algorithm two images are taken for comparison. These frames are resized into 600*600 sizes and r, g, b co-ordinates coveted into gray scale co-ordinates. Then that image is divided into 5*5 blocks. Average of the each matrix block is calculated. Average of the first image is represented by co-ordinates r, g, b. And average of next block represented by r1, g1, b1. Then we calculate total number of change. We calculate difference between average of first image and second image.

It difference is negative then we multiply it by minus sign to make it positive. We set particular threshold value. This difference is compared with the threshold value. If the difference is less than threshold value then it is considered as environmental change otherwise it is considered as motion change.

So in this algorithm, frames of the video are divided into matrix form. Then each block mean square is compared to the very next frame and change is detected.

2) Color Histogram:

In color histogram there are four methods.

Those are Intersection, Chi-square, Correlation, Bhattacharya. In our project we are implemented Bhattacharya method.

Distribution of the color in an image is shown by the color histogram. A color histogram represents the number of pixels that have colors in each of a fixed list of color ranges. Color histogram can be of N dimensional.

Threshold value for Bhattacharya is 0.02 .Threshold is calculated at the runtime.

Formula for Bhattacharya is:

$$d_{bhattacharya}(H1, H2) : \sqrt{1 - \sum_i \frac{\sqrt{H1(i).H2(i)}}{\sqrt{\sum_i H1(i).\sum_i H2(i)}}}$$

Where,

$H1$: *Histogram of image* 1

$H2$: *Histogram of image* 2

In Bhattacharya,

Perfect match is indicated by 0.

Total mismatch indicated by 1.

Low score indicates good matches and high score indicates bad matches.

Threshold value for Correlation is 0.998

Formula for Correlation is,

$$d_{correlation}(H1, H2) : \frac{\sum_i H1^1(i).H2^1(i)}{\sqrt{\sum_i H1^{1^2}(i).H2^{1^2}(i)}}$$

$H1$: *Histogram of image* 1

$H2$: *Histogram of image* 2

In correlation,

Perfect match is indicated by 1.

Total mismatch indicated by -1.

A value of 0 indicates no correlation (random association).

High score indicates good matches and Low score indicates bad matches.

3) SSIM Index:

SSIM Index depends upon three factors. These are luminance, Contrast, structure. Quality of the image is determined by this method. To avoid drawback of previous method this method in designed.

Luminance:

Luminance is quantity of light that is passed through or reflected from certain area.

For luminance 1(i.e values >0.92) represents perfect match and values less than 1 represents mismatch.

Formula for luminance is,

$$\mu_x : \frac{1}{N} \sum_{i=0}^{N-1} xi$$

$$\mu_y : \frac{1}{N} \sum_{i=0}^{N-1} yi$$

Where,

μ_x : *average of x*

μ_y : *average of y*

$$\ell(x, y) : \frac{2\mu_x \mu_y + C1}{\mu_x^2 + \mu_y^2 + C1}$$

Where C1 is the constant.

Contrast:

Subtracting maximum pixel intensity from minimum pixel intensity is known as contrast.

Formula for contrast is,

$$\sigma_x : \left(\frac{1}{N-1} \sum_{i=0}^{N-1} (x_i - \mu_x)^2\right)^{1/2}$$

$$\sigma_y : \left(\frac{1}{N-1} \sum_{i=0}^{N-1} (y_i - \mu_y)^2\right)^{1/2}$$

σ_x : var *iance of x*

σ_y : var *iance of y*

$$c(x, y) = \frac{\sigma_x \sigma_y + c2}{\sigma_x^2 + \sigma_y^2 + c2}$$

Where C2 is constant.

Structure:

It represents arrangement or organization. Pixels which are very close to each other have a greater inter dependency. More important information is carried out by these dependencies regarding structure of objects in scene.

Formula for structure is:

$$\sigma_{xy} : \frac{1}{N-1} \sum_{i=0}^{N-1} (xi - \mu_x)(yi - \mu_y)$$

$$S(x, y) = \frac{\sigma_{xy} + C3}{\sigma_x \sigma_y + C3}$$

Formula for SSIM Index given as:

$$\text{SSIM}(x, y) : \frac{(2\mu_x\mu_y + C1)(2\sigma_{xy} + C2)}{(\mu_x^2 + \mu_y^2 + C1)(\sigma_x^2 + \sigma_y^2 + C2)}$$

VI. EXPERIMENTAL RESULTS

Screenshots:

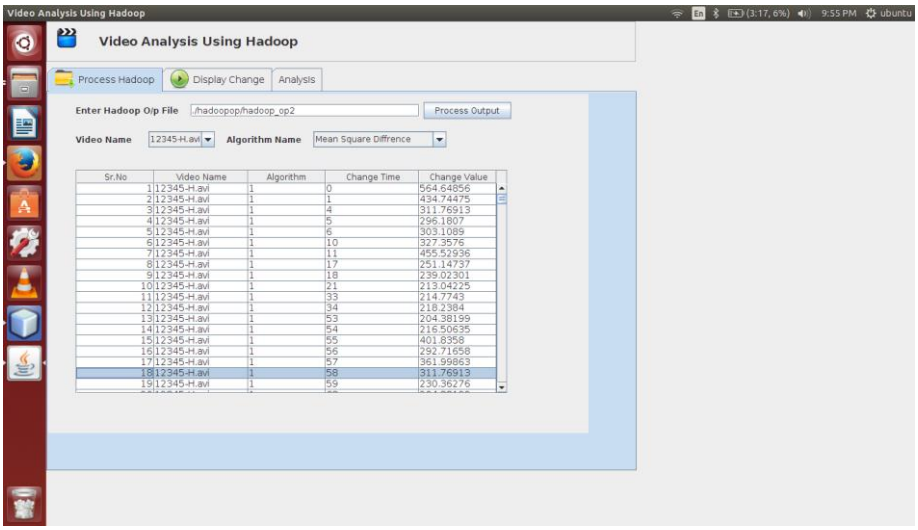

Fig.2.1. Processing video extraction on Hadoop

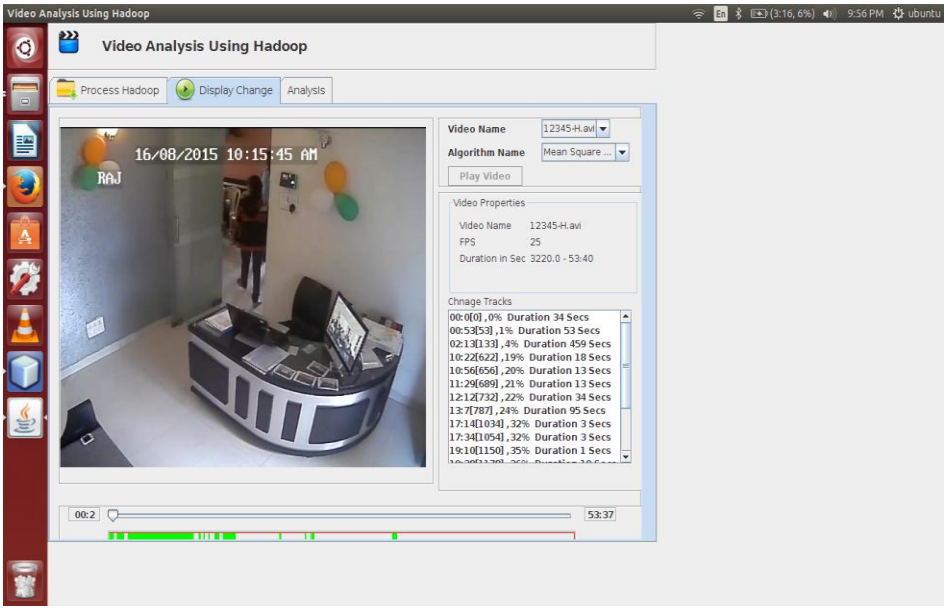

Fig.2.2. Detected scene change is shown with green colour

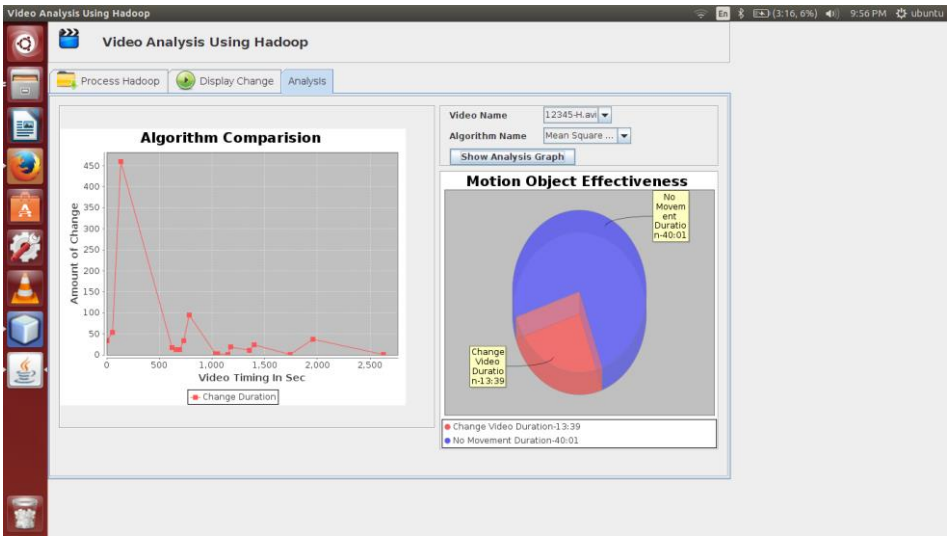

Fig.2.3.Video analysis shown in terms of algorithm comparison and motion object effectiveness

FUTURE RESEARCH DIRECTION

This paper provides further guidelines about future researches and invention of new features like as a face detection. The outlines are given as below:

Implementation of a system in such a way that it will detect the face of a person in a precise way.

Detecting environmental changes up to full extent with minimum error rate.

This implemented system works on historic data hence designing a system which will work both online and offline.

CONCLUSION

The implemented system is more secure, reliable and transparent than the normal existing system. As Hadoop and map reduce framework are used time required for analyzing and processing the whole video is minimized. Up to certain level environmental changes are also have been detected. Total cost estimation is lowered. Fast processing along with better improved result is given by implemented system.

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