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Design and Implementation of Deep Anomaly Activities Detection Using CNN, SVM Technologies and Video Processing

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ABSTRACT: People in the present world each and everyone thinks about one thing that's security. Providing this security depends on various things. An Anomaly activity is any observed action that could specify a person may be involved in a crime or about to commit a criminality. Anomaly detection is nothing but detecting abnormal activity. Analysis of the information captured using these cameras can play effective roles in event prediction, online monitoring applications including anomalies. Nowadays, various machine learning techniques have been used to detect anomalies such as convolutional neural networks, amongst them Support Vector Machine using machine learning techniques improved the detection accuracy significantly. The goal is to propose a new method based on SVM and CNN techniques for anomaly detection with higher accuracy. By using this method to Detect anomaly activity in public places like trying to kill someone, fighting with each other etc. In case any abnormalities are detected the update will automatically share with the concerned person (police station) through Global System for Mobile Communication (GSM) with include of Global Positioning System (GPS) technologies.

KEYWORDS: Anomaly activities detection, SVM and CNN techniques for anomaly detection, Deep anomaly detection using GPS and GSM, Video anomaly detection.

I. INTRODUCTION

In computer vision areas, such as surveillance systems, it is prohibitively costly, challenging, and complicated to manually analyze these abounded data. Common approaches to overcome these difficulties need to use more effective algorithms to provide automatic methods that resulted less cost on hardware and more security. One of the main goals of utilizing automatic surveillance systems is to detect abnormal behavior of subjects in videos. It needs to be considered that most of the frame consisted of normal events, but abnormal events usually occurred in small number of frames. Abnormality can be defined in the context which means a specific action can be considered normal, while abnormal in another one. The diversity of abnormal events and the small amount of information about them make the separation of abnormal. Evidence suggests that surveillance systems can reduce the incidence rate of hospital assault-related attendances. Investigated the relationship between surveillance system installations on violence.

Suspicious human activity recognition from surveillance video is an active research area of image processing and computer vision. Through the visual surveillance, human activities can be monitored in sensitive and public areas such as bus stations, railway stations, airports, banks, shopping malls, school and colleges, parking lots, roads, etc. to prevent terrorism, theft, accidents and illegal parking, vandalism, fighting, chain snatching, crime and other suspicious activities. It is very difficult to watch public places continuously, therefore an intelligent video surveillance is required that can monitor the human activities in real-time and categorize them as usual and unusual activities; and can generate an alert. Recent decade witnessed a good number of publications in the field of visual surveillance to recognize the abnormal activities. The state-of-the-art which demonstrates the overall progress of suspicious activity recognition from the surveillance videos in the last decade. We include a brief introduction of the suspicious human activity recognition



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with its issues and challenges. This paper consists of six abnormal activities such as abandoned object detection, theft detection, fall detection, accidents and illegal parking detection on the road, violence activity detection, and fire detection. In general, we have discussed all the steps that have been followed to recognize the human activity from the surveillance videos in the literature; such as foreground object extraction, object detection based on tracking or non-tracking methods, feature extraction, classification; activity analysis and recognition. The objective of this paper is to provide the literature review of six different suspicious activity recognition systems with its general framework to the researchers of this field.

II. LITERATURE REVIEW

M. Bertini, A. Bimbo and L. Seidenari, "Multi-scale and real-time nonparametric approach for anomaly detection and localization," *Computer Vision and Image Understanding*. [2] M. JavanRoshtkhari and M.D. Levine proposed the system "An on-line, real-time learning method for detecting anomalies in videos using spatio-temporal compositions". [3] Alisha (2018) Abnormal activity recognition and its detection becomes a major task in surveillance videos. In the context of security purposes, it becomes more challenging to identify the abnormal events or activities in video surveillance. Surveillance closely observes, monitors and identify the behaviour of any object like people, suspicious thing or any abnormal activity. Technology is increases very fast, it becomes easier to identify and detect the abnormal activities. There are a lot of techniques and methods are available in field of detection of abnormal activities. In this paper, we discuss about the various methods and techniques and discuss about their advantages and disadvantages. And also compare these technologies based upon their performance. In related work, there are many techniques like Spatio-temporal Saliency Detection, Graph Formulation, Oriented GMM, Based upon Sparse reconstruction and using Statistical Hypothesis Detector etc. [4] Yan Fu (2019) proposed a Abnormal activity recognition is considered as the most challenging task in surveillance videos. Due to the traditional method depend on the computation of artificial features, and noise data has some influence on the extracted features. In this paper, a new hybrid deep learning structure was proposed to fuse the extracted features, which integrates convolutional neural network (CNN) and long short-term memory network (LSTM). Firstly, the video was preprocessed and extracted visual features by CNN. Next, LSTM was used to learn the temporal features of visual features and added attention mechanism to select important features. Finally, the video feature vector obtained layer by layer to judge abnormal activity. An experiment is used to test the ability of the model on the standard dataset UMN to recognize abnormal activity, the result shows that our experimental demonstrate high performance of recognition and outperform the state-of-art algorithms. [5] V. Chandola, A. Banerjee and V. Kumar implemented an "Anomaly Detection: A Survey," *ACM Computing Surveys*. [6] A. Adam, E. Rivlin, I. Shimshoni and D. Reinitz, "Robust real-time unusual event detection using multiple fixedlocation monitors," [7] A. Basharat. Gritai and M. Shah are proposed the system "Learning object motion patterns for anomaly detection and improved object detection," [8] B. Morris and M. Trivedi is proposed the system "Trajectory learning for activity understanding: unsupervised, multilevel, and long-term adaptive approach," *IEEE Transactions on Pattern Analysis and Machine Intelligence*. [9] M. Jain, H. J'egou and P. Bouthemy are explained about "Better exploiting motion for better action recognition," *Computer Vision and Pattern Recognition (CVPR)*. [10] Royston Rodrigues, NehaBhargava, SubhasisChaudhuri, RajbabuVelmurugan Derivatives of this system include a "Multi-timescale Trajectory Prediction for Abnormal Human Activity Detection". [11] Amanda Ziemann, Hope Simonoko, and Eric Flynn implementations include a paper "TEMPORAL ANOMALY DETECTION IN MULTISPECTRAL IMAGERY". [12] Marzieh.Babae, Maryam Imani According to statistics, "Anomaly Detection Improvement Using Sparse Representation and Morphological Profile". [13] Dingsheng Deng proposed the system "Research on Anomaly Detection Method Based on DBSCAN Clustering Algorithm".

III. METHODOLOGY

Nowadays, various machine learning techniques have been used to detect anomalies such as **convolutional neural networks**, amongst them **Support Vector Machine** using machine learning techniques improved the detection accuracy significantly. The goal is to propose a new method based on SVM and CNN techniques for anomaly detection with higher accuracy.

- Convolutional Neural Networks
- SVM

3.1 BLOCK DIAGRAM

Figure 3.1 represents the block diagram of the convolutional neural networks (CNN), and SVM used for suspicious activity detection. In which the input image/video from the dataset is pre-processed and the features are extracted using the convolutional layer and RELU layer. This method proposed an integrated pipeline that incorporates the output of object analysis pixel-based analysis for abnormal behavior inference. This enables to detect of abnormal behaviors.

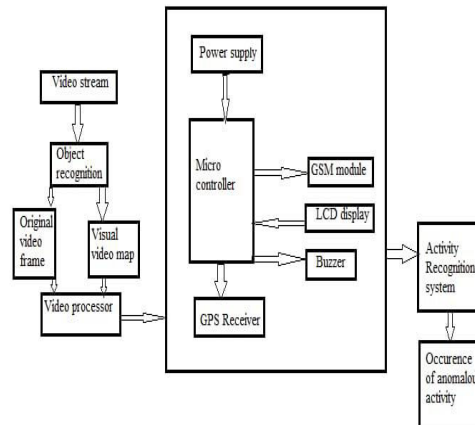


Fig .3.1 BLOCK DIAGRAM

3.2 CONVOLUTIONAL NEURAL NETWORKS

In neural networks, Convolutional neural network (ConvNets or CNNs) is one of the main categories to do images recognition, images classifications. CNN image classifications takes an input image, process it and classify it under certain categories. Computers sees an input image as array of pixels and it depends on the image resolution. Based on the image resolution, it will see $h \times w \times d$ (h = Height, w = Width, d = Dimension).

Technically, deep learning CNN models to train and test, each input image will pass it through a series of convolution layers with filters (Kernels), Pooling, fully connected layers and apply Sigmoid function to classify an object with probabilistic values between 0 and 1. The figure 3.2 represents the complete flow of CNN to process an input image and classifies the objects based on values.

3.2.1 ALGORITHM IMPLEMENTATION

Algorithm for CNN

- Step 1. Get the input images.
- Step 2. Pre-processing of images.
- Step 3. First convolution layer with kernel matrix.
- Step 4. First maximum pooling layer.
- Step 5. Second convolutional layer with kernel matrix.
- Step 6. Second maximum pooling layer.
- Step 7. Flattening of images ie. 3D to 1D
- Step 8. Finally, the fully connected layer with the activation function of softmax to classify the image

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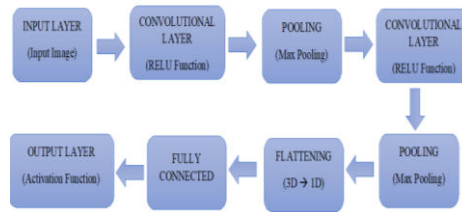


Fig.3.2 Block Diagram of CNN Algorithm

Convolution Layer

Convolution is the first layer to extract features from an input image. Convolution preserves the relationship between pixels by learning image features using small squares of input data as shown in figure 3.3. It is a mathematical operation that takes two inputs such as image matrix and a filter or kernel.

Strides

Stride is the number of pixels shifts over the input matrix. When the stride is 1 then we move the filters to 1 pixel at a time. When the stride is 2 then we move the filters to 2 pixels at a time and so on. The figure 3.4 shows convolution work with a stride of 2.

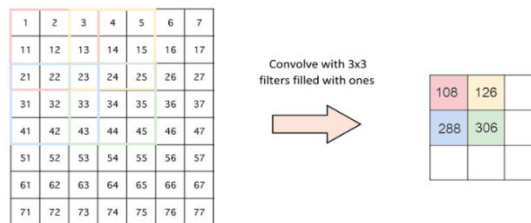


Figure 3.4 Stride with Value of 2

Padding

Padding can be performed using two different ways as follows,

- Pad the picture with zeros (zero-padding) so that it fits
- Drop the part of the image where the filter did not fit.
- This is called valid padding which keeps only valid part of the image.

Non Linearity (RELU)

- ReLU stands for Rectified Linear Unit for a non-linear operation. The output is $f(x) = \max(0, x)$ as shown in figure 3.5.

ReLU’s purpose is to introduce non-linearity in our ConvNet. Since, the real world data would want our ConvNet to learn would be non-negative linear values.

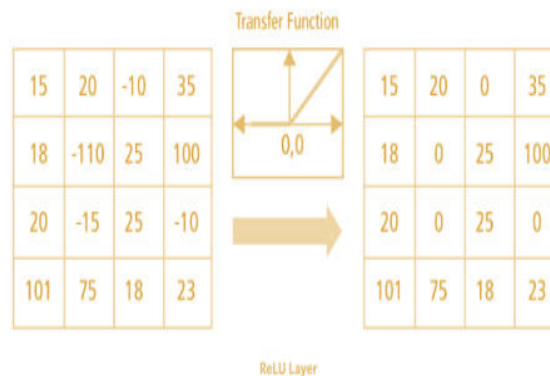


Figure 3.5 Relu Function

There are other non-linear functions such as tanh or sigmoid that can also be used instead of ReLU. Most of the data scientists use ReLU since performance wise ReLU is better than the other two.

Pooling Layer

Pooling layers section would reduce the number of parameters when the images are too large. Spatial pooling also called subsampling or down-sampling which reduces the dimensionality of each map but retains important information. Spatial pooling can different types:

- Max Pooling
- Average Pooling
- Sum Pooling

Max pooling takes the largest element from the rectified feature map as shown in figure 3.6. Taking the largest element could also take the average pooling. Sum of all elements in the feature map call as sum pooling.

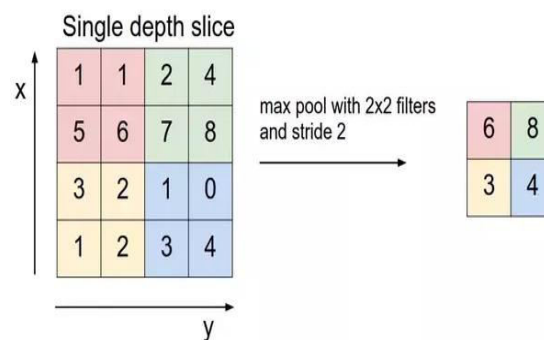


Fig3.6 Max Pooling with Stride Value of 2

Fully Connected Layer

The layer we call as FC layer, we flattened our matrix into vector and feed it into a fully connected layer like a neural network.

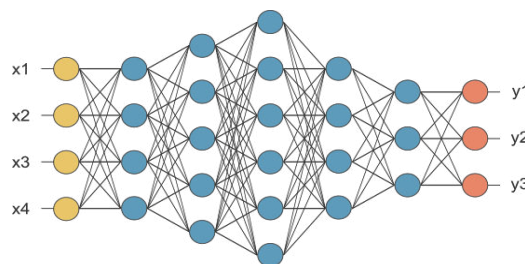


Figure 3.7 Fully Connected Layer

Figure 3.7 represents the feature map matrix will be converted as vector ($x_1, x_2, x_3 \dots$). With the fully connected layers, we combined these features together to create a model. Finally, we have an activation function called sigmoid to classify the outputs as Bacterial Blight or Black Rot or Cercospora or Anthraconse.

3.3SUPPORT VECTOR MACHINE ALGORITHM

Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning.



The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane.

SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector.Machine. Consider the below diagram in which there are two different categories that are classified using a decision boundary or hyperplane.

STEPS IN SVM ALGORITHM:

Step 1: Load the important libraries. ...

Step 2: Import dataset and extract the X variables and Y separately. ...

Step 3: Divide the dataset into train and test. ...

Step 4: Initializing the SVM classifier model.

Step 5: Fitting the SVM classifier model. ...

Step 6: Coming up with predictions.

IV. SYSTEM DESIGN AND IMPLEMENTATION

MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB, you can analyze data, develop algorithms, and create models and applications. The language, tools, and built-in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java You can use MATLAB for a range of applications, including signal processing and communications, image and video processing, control systems, test and measurement, computational finance, and computational biology. More than a million engineers and scientists in industry and academia use MATLAB, the language of technical computing.

- High-level language for numerical computation, visualization, and application development
- Interactive environment for iterative exploration, design, and problem solving
- Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration, and solving ordinary differential equations
- Built-in graphics for visualizing data and tools for creating custom plots
- Development tools for improving code quality and maintain ability and maximizing Performance
- Tools for building applications with custom graphical interfaces.
- Functions for integrating MATLAB based algorithms with external applications and Languages such as C, Java, .NET, and Microsoft Excel

Numeric Computation

MATLAB provides a range of numerical computation methods for analyzing data, developing algorithms, and creating models. The MATLAB language includes mathematical functions that support common engineering and science operations Core math functions use processor-optimized libraries to provide fast execution of vector and matrix calculations.

Available methods include:

- Interpolation and regression
- Differentiation and integration
- Linear systems of equations and Fourier analysis
- Eigen values and singular values
- Ordinary differential equations (ODEs) and sparse matrices

MATLAB add-on products provide functions in specialized areas such as statistics, optimization, signal analysis, and machine learning.

Data Analysis and Visualization

MATLAB provides tools to acquire, analyze, and visualize data, enabling you to gain insight into your data in a fraction of the time it would take using spreadsheets or traditional programming languages. You can also document and share your results through plots and reports or as published MATLAB code.

Image Acquisition

Image Acquisition Toolbox™ enables you to acquire images and video from cameras and frame grabbers directly into MATLAB and SIMULINK. You can detect hardware automatically and configure hardware properties. Advanced workflows let you trigger acquisition while processing in-the-loop, perform background acquisition, and synchronize sampling across several multimodal devices. With support for multiple hardware vendors and industry standards, you can use imaging devices ranging from inexpensive Web cameras to high-end scientific and industrial devices that meet low-light, high-speed, and other challenging requirements.

GPS Modem

The signal contains data that a receiver uses to compute the locations of the satellites and to make other adjustments needed for accurate positioning. The receiver uses the time difference between the time of signal reception and the broadcast time to compute the distance, or range, from the receiver to the satellite.



Figure 4.1 GPS Module

GSM Modem

This GSM Modem can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. Advantage of using this modem will be that you can use its RS232 port to communicate and develop embedded applications. Applications like SMS Control, data transfer, remote control and logging can be developed easily. The modem can either be connected to PC serial port directly or to any microcontroller.



Figure 4.2 GSM Module

Support Vector Machine(SVM)

In machine learning, support vector machines (SVMs, also support vector networks are supervised learning models with associated learning algorithms that analyzedata used for classification and regression analysis. Given a set of training examples, each marked for belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible.

In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces.

When data are not labeled, supervised learning is not possible, and an unsupervised learning approach is required, which attempts to find natural clustering of the data to groups, and then map new data to these formed groups. The clustering algorithm which provides an improvement to the support vector machines is called support vector clustering and is often used in industrial applications either when data is not labeled or when only some data is labeled as a preprocessing for a classification pass.

V. SYSTEM TESTING AND EVALUATION

The algorithm of CNN and SVM for classification. For the classification of abnormal activities in society a Matlab is used for processing it. The CNN and SVM algorithm is trained with 100+ images and abnormality has been tested in that. The model obtained an accuracy of 96%.

The accuracy of this project more than the expected output efficiency.

The proposed system is developed with the help of various machine learning algorithms such as CNN and SVM. Both has been used for the detection of abnormal activities. 1000 + data have been taken for training. From that 100 data are trained.

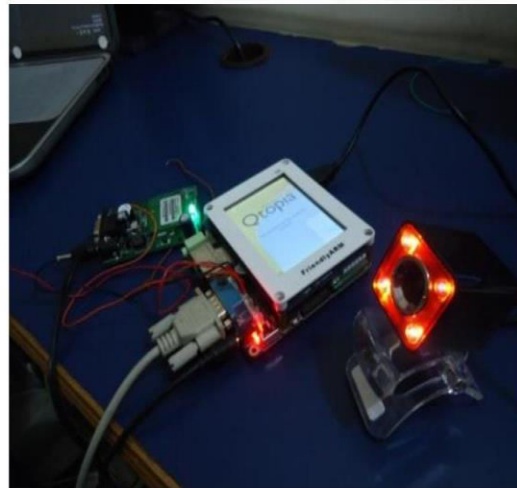


Figure 5.1 Hardware kit

To evaluate the proposed method and compare it with other available methods, public UCSD dataset is used which is one of the most famous dataset related to the anomaly detection. This dataset is related to the pedestrian walkway surveillance camera. Any objects other than people are identified as anomaly, such as bicycle or car. This dataset has ped1 and ped2 parts that are related to cameras with a different angle. Both parts have test and train data. Abnormal event detection is now a challenging task, especially for crowded scenes. Many existing methods learning normal event model in the training phase, and events which cannot be well represented are treated as abnormalities it fails to make use of abnormal event patterns, which are elements to comprise abnormal events. Moreover normal patterns in testing images may be divergent from training ones, due to the existence of abnormalities. Anomaly detection finds extensive use in a wide variety of applications such as murder and kidnap. Nowadays, vacuum machine learning techniques have been used to detect anomalies such as convolutional neural networks, amongst them Support Vector Machine using machine learning techniques improved the detection accuracy significantly. The goal is to propose a new method based on SVM and CNN techniques for anomaly detection with higher accuracy, the proposed detector treats each sample as a combination of a set of event patterns. Due to the unavailability of labelled abnormalities for training, abnormal patterns are adaptively extracted from incoming unlabeled testing samples. Suspicious human activity recognition from video processing is an active research area of image processing. Through visual surveillance, human activities can be monitored in sensitive and public areas In case any anomaly activity is detected then the intimation will be shared with the nearby police station through wireless communication using GSM. At the same time, a buzzer will turn ON.



Figure 5.3 Sample Output



VI. CONCLUSION

In this project a machine learning based framework for anomaly detection is proposed. Motion fusion block is designed to maintain motion and appearance cues. The feature transfer block is used to extract the features by using CNN and SVM architectures and it exploits the transferability of the neural network from different tasks/domains. The proposed model is effective in discriminating normal events from abnormal events. In the future, we can implement this system with a real-time camera. So that the process will be shown for real-time inputs.

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