CCTV Analytics Software

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Abstract:

It has been observed that installation of CCTV cameras does not necessarily help prevent them. Therefore, we propose a machine learning based solution that can generate real-time alerts if any suspicious activity is recorded by the CCTV cameras.

1.0 Introduction:

Many organisations, residential buildings and even public spaces all over the world have resorted to the use of CCTV cameras to ensure safety in their premises. Over the past few decades, a steady rise in areas under CCTV surveillance has been recorded. Ideally, this should have had an inverse impact on the number of recorded crimes, however, the crime rates continue to remain unaffected. One reason behind this is that, the crimes being committed only get recorded by the CCTV cameras. This can help identify the offenders but it does not help stop the crime from taking place. This is where Machine Learning can provide a solution. Computer Vision can be used to run analytics on the CCTV recording in real time and alerts can be generated and sent to the authorities concerned to curb the crime.

2.0 Customer Needs Assessment

It would save a lot of human effort and cost if the CCTV footage would not have to be monitored constantly to ensure safety in the premises. This is something that an ML solution can offer. The solution will send alerts to the concerned authorities right when a criminal activity is detected. Thus, it need not be monitored constantly.

3.0 Revised Needs Statement and Target Specifications

1. To report detected suspicious activity in real time
2. Solution that aids the prevention of criminal activity
3. Reduction of manual effort
4. Cost-effective in the long run

The above mentioned targets can be achieved by identifying the the common offences recorded such as:

1. Burglary
2. Infiltration
3. Arson
4. Fighting
5. Assault
6. Detection of weapons

The proposed solution will consist of a machine learning model that runs on the CCTV footage at the backend and will generate alerts to the concerned authorities. These alerts can also be backed with a report, giving a brief description of the detected suspected activity along with a snapshot of the same so that further decisions can be made by the authorities.

4. External Search

The main inspiration behind this solution is the problem statement provided for the Kavach 2023 hackathon:

Kavach 2023 problem statement 009

Other referred sources are listed below:

Rise of CCTV surveillance in India but unaffected crime rates

CCTV surveillance for crime prevention

4.1 Benchmarking

The following site lists the products available that address the problem statement of this report in varying degrees. It is, however, not possible to assess the degree to which these solutions address the problem statement since most of them are paid services:

Video analytics softwares

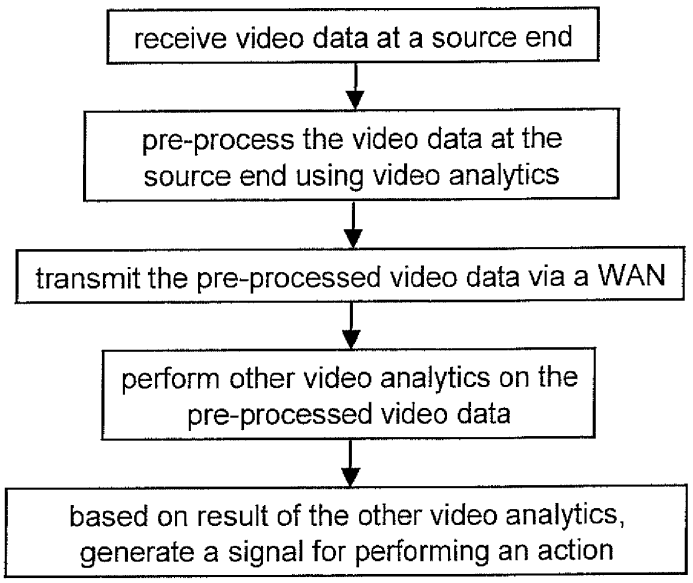
4.2 Applicable Patents

Patent 1 - Apparatus for CCTV Video Analytics Based on Object-Image Recognition DCNN

This patent discusses the application of DCNN (Deep Convolutional Neural Network) to CCTV footage for object detection, detection of events as per the designated rules (here, criminal/ suspicious activity). The patent also focuses on reducing the load on image and video processing.

Patent 2 - Video analytics with pre-processing at the source end

This patent proposes a method to preprocess the captured data at the source end so as to reduce the bandwidth required to transmit the video/image data over a WAN (Wide Area Network). The flow can be visualised as below:



(Image taken from patent documentation)

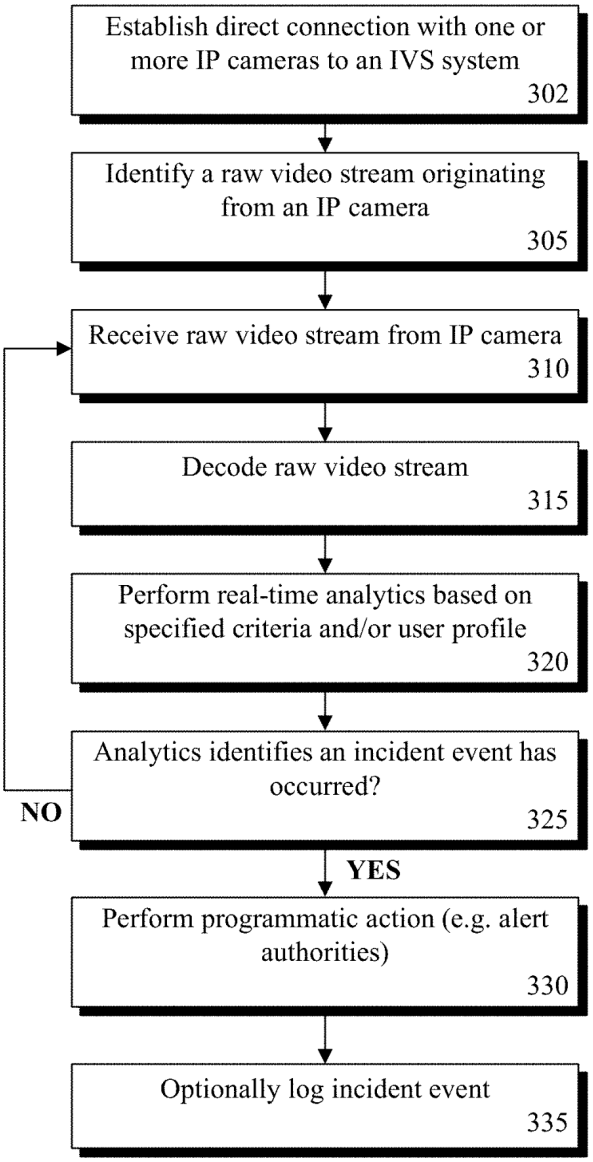
This can be used in combination with the solution proposed by Patent 1 to further optimise the results.

Patent 3 - Image processing noise reduction

The video data taken from the CCTV images will be processed at the backend in the form of image frames. The solution proposed in the patent can be used to reduce the noise from the images and can thus reduce the processing load and quality of analysis.

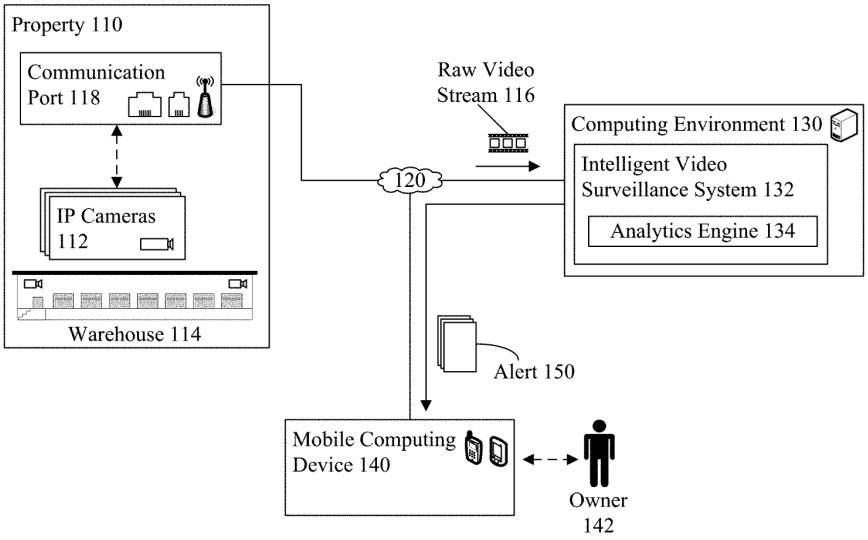
[Patent 4 - Network based video analytics through an application program interface (API) with metric triggered notifications]

The basic idea here is that the server extracts one or more metrics by analysing the video input (from the CCTV cameras, as per our problem statement) and decides whether the input should trigger a notification to the authorities or not based on a TRUE/FALSE result value obtained from the computations over the video input.
The flow can be visualised as:



(Image taken from patent documentation)

This patent can be used for our respective problem statement to design the procedure to generate notification alerts to the concerned authorities upon detection of suspicious activity. The overall system could be visualised as:



(Image taken from patent documentation)

[Patent 5 - Alert generation based on event detection in a video feed]

[Patent 6 - Method and apparatus to search video data for an object of interest]

This patent can be used for our problem statement to specifically detect crimes involving the use of weapons. This solution can be used to define trigger objects to be detected from the video stream.

4.3 Applicable Standards

The following government regulation might be applicable while dealing with public spaces under CCTV surveillance and handling the recorded data:

- Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules, 2011, under the Information Technology Act, 2000, which provided guidelines for the collection, storage, and use of personal information by organisations.
  Consent is required from individuals before collecting, storing and using their personal information and to put in place necessary security measures and procedures to protect this information from unauthorised access, disclosure, or destruction.

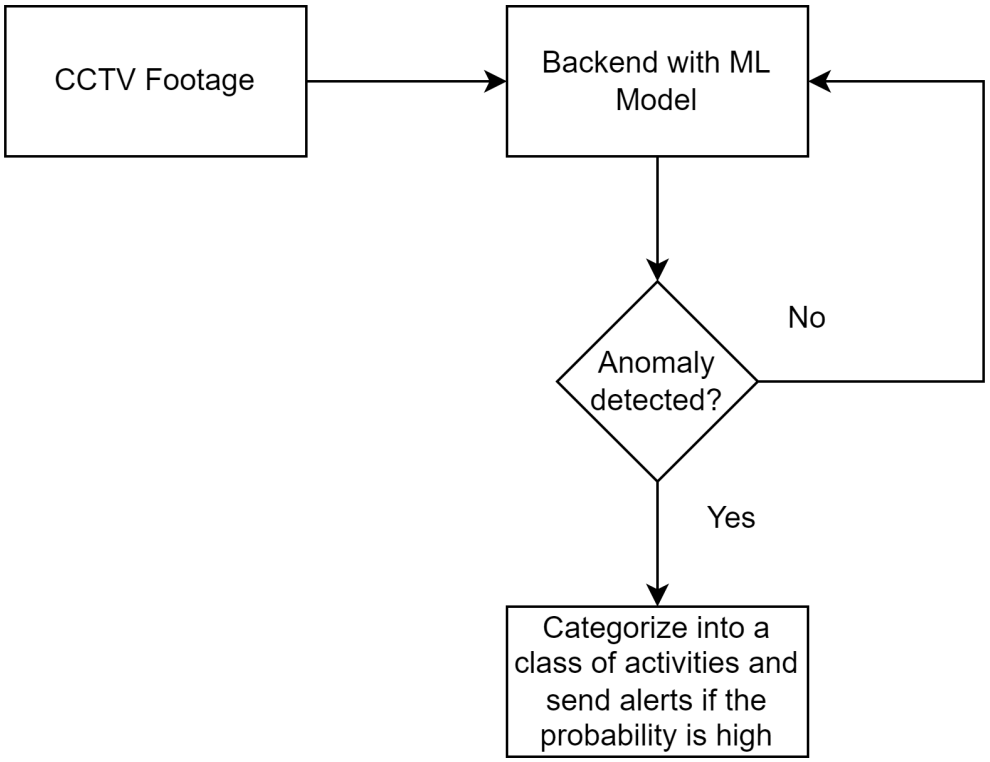
4.4 Applicable Constraints

The following constraints can be noted with respect to our proposed system:

- CCTV cameras are not fully functional without electricity. Modern CCTV systems have a backup battery. But even the battery capacity needs to be checked from time to time, and the battery needs to be replaced if necessary.
- Bandwidth constraints - the CCTV camera footage is video data which needs to be analysed by our project. Transmitting this data would require significant bandwidth, even with processing at the source end.

5.0 Concept Generation

The general flow of the solution can now be imagined as:



6.0 Final Design

As a business idea, this solution can be offered to organisations offering CCTV services to integrate it with their monitoring systems or can even be offered separately to individual entities already using CCTV systems and wanting to upgrade them.
The final design can be broken down into the following steps:

1. CCTV footage : The CCTV footage input stream will be continuously analysed by the ML model in the backend.
2. If any suspicious activity is recorded, the solution will categorise it in one of the provided categories and if the probability of it being accurate is high, then alerts will be sent to the concerned authorities.
3. These alerts can also be combined with brief details of the recorded activity and a snapshot of the same so further decisions can be made to possibly prevent a potential mishappening.

The machine learning model can make use of the pre-existing Detectron2 framework, proposed by Meta.

7.0 Conclusions

It has been noticed that installation of CCTV systems do not necessarily ensure prevention of crimes, but only provide means to document it for further investigation. This solution focuses on sending real-time updates upon detection of suspicious activity so that any potential criminal activity could be prevented.
This solution could be useful for existing CCTV service providers to upgrade their existing software or even for individual entities or smaller organisations that wish to add this explicitly to their existing CCTV systems.

References:

1. Kavach 2023 problem statement 009
2. Video analysis with Python
3. Video analysis Github project - kaledhoshme123
4. Real-world Anomaly Detection in Surveillance Videos
5. Detectron2 - MetaAI