WHITE PAPER – Comparison with rule-based video analytic systems

Why rule-based video analytic systems alone are simply not adequate

Current video analytic systems define rules in order to specify the detection of a particular behaviour or event. For example, in order to detect a "perimeter intrusion" event, a virtual trip wire has to be specified in the region of interest. The rule is set such that if this line is crossed by a human or object, the "perimeter intrusion" event is deemed to have occurred and this violation will lead to an alert.

The inherent problem with rule-based analytics is that every rule is set to detect only a specific behaviour (e.g. perimeter intrusion) and has to achieve this with a high level of accuracy. Much time and effort is then put into configuring this rule and fine-tuning it to achieve the desired performance. If this particular event (i.e. perimeter intrusion) does not occur, then the rule is basically dormant doing nothing and produces no value. To make matters worse, it is often inappropriately applied, producing false alarms instead of positive detections, adding to frustration of the users.

Therefore, rule-based video analytic systems suffer many shortcomings:

1) **Only capable of detecting simple known behaviours** - In order for a rule to be drawn, the operator needs to have some prior experience as to what kind of rules to apply for the different scenarios. This means that he/she needs to know beforehand the kind of behaviour/event they wish to detect. In many instances, this may be limited to simple behaviours that we can predict or wish to prevent against. However, what about other unusual or unwanted abnormal behaviours that we might not have thought about?
2) **Not possible to specify all rule combinations –** You may specify a rule in one location but what if the violation happens in another location in the scene? It is not possible to figure out all the possible combinations of rules or even think of all the possible behaviours can could take place.
3) **Limited coverage** - Since rules are effective to detect only simple behaviours that are known beforehand, then they are mostly limited to protection of perimeters, exits or entrances where a simple rule can be specified. In a city-wide surveillance deployment of thousands of cameras, these usually represent a small fraction of the number of cameras many of which are not looking at such areas. Some statistics have shown that less than 10% of the deployed cameras have effective video analytics.
4) **Inappropriate use leads to high false alarm rates –** Since the only approach over the past 10 years have been the use of rule-based analytics, users have no choice but to try to apply them to all kinds of scenarios in order to automate surveillance monitoring. However, this inappropriate use of rules has often led to high false alarm rates.

5) **Some scenarios are difficult to specify any rules –** Complex scenarios with large movements of crowd means that it is often not possible to specify any rules beforehand.
6) **Time consuming in rule configurations –** Many hours are needed to first setup and configure the rule and later test it for accuracy in detecting the specified event. This is highly inefficient and not scalable for thousands of cameras.
7) **A new rule/template has to be defined for each new behaviour to be detected** – Rule-based methods require the algorithms to first be trained to recognize a specific event or behaviour. This means a parametric template is often used. This means that every time a new behaviour is to be detected, a new template has to be developed just for the new behaviour and often cannot be used for others.

Comparison with traditional rule-based video analytic systems

Our technology ARVAS uses an unsupervised machine learning approach which does not require users to specify rules for detection. Here we make a comparison between our method and a typical rule-based video analytic system.

Feature	Rule-based VA System	ARVAS
Behaviour and event detection capability	**Limited and restrictive –** Behaviours and events must be simple and user pre-defined (or limited to those provided by vendor). E.g. trip wires, perimeter intrusions and loitering.	**Unlimited and unrestrictive –** Capable of detecting unlimited set of behaviours and events, even those complex and unknown beforehand. E.g. mischief and anti-social behaviours such as vandalism, aggressions, theft; safety events such as children dashing and playing on roads, obstructions to traffic; changes to public environment such as new installations, activity patterns which represent deviations from normal routine such as dubious maintenance works, suspicious loitering and unusual crowd activity.
Setup and calibration	**Tedious and time-consuming** - Need to pre-configure rules for each behaviour (e.g. loitering, perimeter intrusion)	**Little to no configuration required** – Autonomous scene learning with no need to set any rules.
Surveillance coverage	**Small % of deployed cameras** – Not all camera views can benefit from setting and applying a rule.	**Potentially 100% possible** – Abnormalities can be discovered in almost any camera view.

Ease of use	**Difficult** – Prior experience and knowledge required to ensure high detection accuracy. Substantial experience needed to fine-tune to achieve high-level of accuracy.	**Very Easy** – Almost no prior experience or skills required. System is able to adapt and self-learn.
Performance Acceptance	**Strict Pass or Fail criteria for alarms** - Any event not within the specified rule is a false alarm due to a strict Pass or Fail criteria.	**Range of acceptance judged by level of relevance of alarms** – All alarms are now evaluated based on how interesting or relevant they are to the user. There is no longer a single pass or fail criteria.

The need for an integrated machine learning and rule approach

Despite the fact that rules have its limitations, they are not redundant. Vi Dimensions has developed an architecture which allows its patent pending unsupervised machine learning technology to be easily integrated with rules. This allows a novel interaction between the 2 methods to achieve greater detection possibilities as well as to reduce false alarms for rules especially in scenarios if a rule had been applied on its own. This leads to a win-win situation for both rule based and non-rule based systems.

With this integrated approach, we propose to use ARVAS as the first line of defence to surface unusual and abnormal activities in a scene. We can then apply specific rules to certain scenes to enhance surveillance and monitoring. Hence, we achieve a more comprehensive approach in surveillance video analytics.

Additionally, ARVAS offers the following practical advantages:

- Able to accept relatively low frame rates and resolutions, accommodating older legacy camera sources
- Able to deploy into cloud based or distributed environments
- GPU acceleration, effectively serving a larger number of cameras per server
- Can be adapted to take into account additional sources of information i.e. IOT sensors etc.

About Vi Dimensions

Vi Dimensions was founded in 2015 with the simple idea that video analytics can be done in a much better and efficient way with the ultimate goal to revolutionize safe city surveillance harnessing thousands of cameras.

The company uses its patented algorithms and proprietary unsupervised Machine Learning techniques to derive meaningful information and actionable insights from live streaming video data. This translates to immediate value to the customer not only in terms of security and surveillance but also improves the organisation's safety, operational and maintenance aspects.

Our advanced and innovative system analyses vast amounts of real-time streaming (or archived) data autonomously for abnormal behavior and events. It does not require human intervention to automatically discover dominant motion patterns which means that unlike conventional systems, it does not require a human to specify rules necessary for detection.

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