CIEFFE Intelligent Motion Detection and Object Behaviour Tracking

The Path to DeePath®

By Dennis Sajdl – © 2003 CIEFFE New Zealand

Introduction

CIEFFE, the creators of PROXIMA and SPECTIVA Digital Video Management Systems and a global force in DVR innovation are proud to present some of their advanced SPECTIVA technologies to the readers of CCTV Focus magazine over the next few issues.

Background

SPECTIVA is CIEFFE's most sophisticated DVMS platform specifically developed to deliver unique, powerful features and unparalleled levels of video and audio recording, transmission and networking performance – up to 25/30* real time images per second for every camera, at full frame, full resolution (720x576/ 720x480* pixels) with lip-synchronised stereo audio. Multiple compression algorithms (Wavelet, MPEG4 and Enpacta™) are available for video transmission, recording and backup, delivering optimum visual quality and performance for every CCTV environment. Some of the features, such as unlimited local and network storage management, neural network motion detection, DeePath®, an anti-terrorism feature, and intelligent searching tools, are totally unique to the SPECTIVA platform and are a result of years of sustained R&D efforts.

The first version of CIEFFE SPECTIVA DVMS was released in May 2002. Similarly to PROXIMA's market position in 2001, SPECTIVA was ahead of its time and the competition, allowing CIEFFE to lead the global Digital CCTV market through forward thinking, innovation and technical expertise.

Having achieved the ultimate in real time digital video recording, network performance and visual quality early we focused our R&D on initiatives that we believed would revolutionise Digital CCTV next - intelligent processing and analysis of all incoming video in real time and new generations of space saving, full resolution, full frame real time video compression.

This article will focus on intelligent video processing and analysis.

SPECTIVA's Neural Network Motion Detector - The Foundations May 2002 -> Now

It is easy to imagine a powerful motion detection engine, able to accurately detect only video with motion that is of interest to the end user (e.g. car movements) and able to disregard various changes in the camera view that are not of interest to the end user (e.g. shadows, rain, clouds etc.) while being confident that no movements of interest are missed. Recording video of interest only has many advantages, including significant storage savings and faster review and search times (less recorded video to process). The majority of readers will be familiar with conventional motion detection engines based on pixel changes between subsequent images/ frames and the difficulties that exist in configuring those engines to eliminate "false" triggers. Eliminating false triggers caused by environmental conditions or other repetitive/unpredictable movements and recording all movements that are valid is a real challenge. Clearly, conventional pixel change motion detection engines are neither very accurate (too many false triggers) nor very reliable (too many missed movements of interest).

During the design stages of SPECTIVA, we were faced with the challenge of creating a motion detection engine that would be capable of delivering accurate and reliable performance while capturing only video of interest and eliminating "false" triggers in any environment, internal or external.

Critical to the high performance of the motion detection engine was creating an algorithm based on neural networks that could analyse many high resolution images in real time (16 channels at 30 IPS per channel requires analysis of 480 images per second) and detect groups or patterns of like pixels (objects), represent them numerically and analyse how these groups or patterns of pixels moved over time. This approach provided a much better platform for motion detection as we were looking at the objects we could describe and follow as opposed to "dumb" pixels which could not be analysed intelligently. Furthermore, our neural networks approach allowed us to introduce zoning. Each camera can have multiple regions (zones), each zone with its own unique motion detection criteria. Adding time and change over time to the mix proved to be extremely valuable in creating a flexible motion detection engine in which object size, speed and location could be defined.

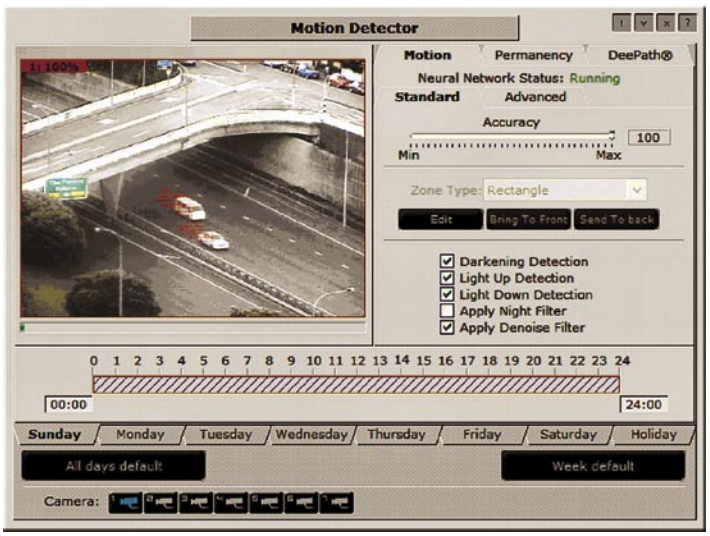
We recognised that in order to have an accurate

motion detection system we could not rely on a static configuration to handle the constantly changing camera conditions (a static configuration is only accurate at the time of configuration), so our neural network algorithm was modified to progressively learn and adapt over time in response to the discovered objects and changing camera conditions. This learning process was essential in providing a motion detection system which was focused on detecting newly introduced objects and movements in the camera view and capable of ignoring background or environmental movements – something that was necessary for successful handling of external environments.

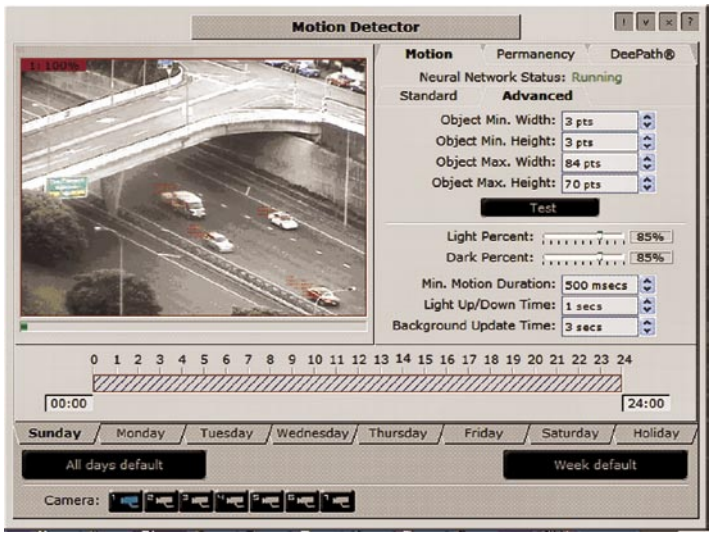
With SPECTIVA's high resolution, high quality images and plenty of spare computing resources due to our hardware compression implementation, we were able to create and provide a real-time image analysis and object recognition engine built-in. When this engine is combined with neural network analysis, it delivers the best results for accurate and reliable motion detection in any environment, day or night, rain or shine.

The screenshots on this page show SPECTIVA's neural network motion detection engine with tools to create multi-layer, multi-zone motion detection criteria with varying object size, speed, light conditions and background update time.

Due to our self-learning algorithm, powerful motion detection performance can be achieved with a fairly simple setup which hides the complexity from the user. Several filters (night filter, denoise filter etc) are available to filter low quality video and thus further enhance motion detection in difficult to handle conditions e.g. poor quality cameras in low lighting conditions result in noisy digital images. All motion detection settings can be configured per camera, per day period providing a very flexible ability to schedule and therefore further refine what constitutes video of interest.



CIEFFE SPECTIVA Motion Detection Setup Screen where zones and other major parameters are defined



CIEFFE SPECTIVA Advanced Motion Detection Setup Screen

SPECTIVA's DeePath® Technology – Taking it to the Next Level
October 2003 -> Now

High quality, high resolution video images and our ability to perform real time analysis and recognise discrete objects like cars, people or boxes provided us with a platform for developing far more powerful motion detection technology. By analysing object tracking and object behaviour, we could generate events that would further narrow down the definition of video of interest through intelligent analysis of object direction, size, speed, object path through the camera view etc. Examples include recording a person walking the wrong way at a customs checkpoint and alerting an operator, recording cars making a right turn but ignoring cars making a left turn on an intersection and so on – there are many applications in which the ability for a digital video management system to make intelligent decisions in real time in response to what its cameras see would be very desirable.

In order to achieve object tracking and behaviour analysis, we had to extend our neural network motion detection model and create new algorithms that would not only discover but also keep track of multiple objects and their movements in a camera view in real time. We have invested heavily into developing the required technology and bundled this new technology into DeePath® - the new Object Tracking and Behaviour module built into every SPECTIVA DVMS.

DeePath® technology is based on discovering discrete objects in real time and tracking each discovered object individually in terms of their paths while they are in the view of the camera. SPECTIVA DeePath® can analyse all objects and track paths for all objects in real time and can be configured to recognise an object or a path that is of interest. The presence of this special object or special path can be used to trigger an event on the system.

Given that we started with a powerful motion (object) detection platform, the major challenge was based around breaking down the configuration process into manageable parts thus defeating the infinite complexity

(multiple trackings, multiple zones, multiple paths, multiple objects as well as time, direction, size and speed can create an infinite combination set – and this is for only one camera!) while maintaining the flexibility and power of the tool.

Users can create two or more zones for any one tracking and a zone stepping sequence for an object which can be used in object path analysis i.e. an object (a car) needs to be present and moving in zone 1 and then make its path to zone 2 (two zones, 1 stepping) and move in zone 2 in order for this entire path to be of interest to the system. With the addition of a time parameter to the stepping definition, we have created a way to examine the speed of an object as well as its movement patterns.

One of the challenges with real time object analysis of real world video is that there can be many objects present within any camera view and many of them are not of interest, even if they happen to be within a particular area of the camera view. This prompted us to introduce object filters for every tracking which would allow us to further define objects which are to be treated as "special" from a large set of objects that may be discovered by our system as moving in any camera view.

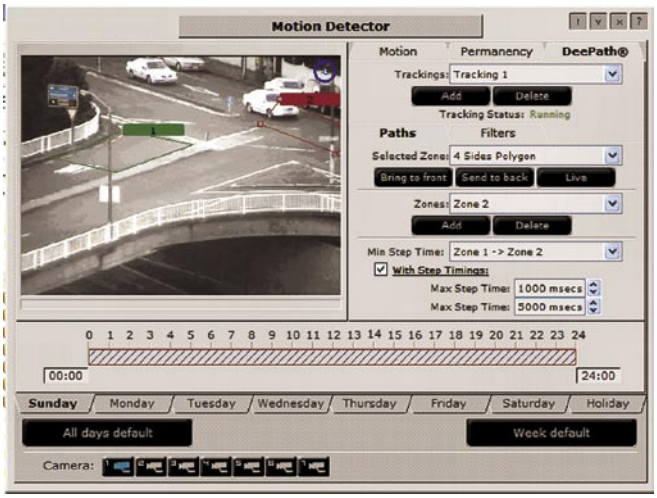
Configuration of time (track only objects which move a minimum of x seconds and no longer than y seconds), direction (track only objects that have a general direction from bottom left to top right of the camera view for example), and proportional shape of an object (track only objects which are tall and narrow) provides a way for a user to be generic but precise about the objects that are to be tracked.

CIEFFE DeePath® provides users with the ability to define multiple trackings for each camera, each representing an event, and allows configuration parameters to vary over time, providing for a very configurable and flexible platform. Two or more DeePath® (or any other type) events can be combined through SPECTIVA's built in custom alarm logic expression builder to create extremely powerful triggering conditions.

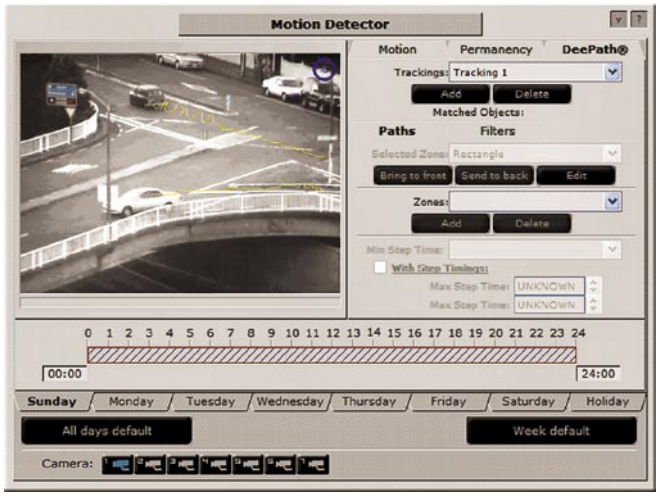
CIEFFE DeePath®, with its object tracking and object behaviour model, associated parameters and custom event logic allow SPECTIVA to analyse all incoming video and make intelligent record and alarm decisions on its own in response to the video it is seeing.

Here at CIEFFE, we are excited to have developed a technology that can provide digital video management systems with sufficient intelligence to offer real time solutions for a great variety of everyday situations without any human input or intervention. We hope this article will help you realise what it takes to provide intelligence to a digital video management system and the benefits that such a system can offer. We strongly believe that intelligent, real time video analysis will have a pivotal role in digital video management systems of tomorrow.

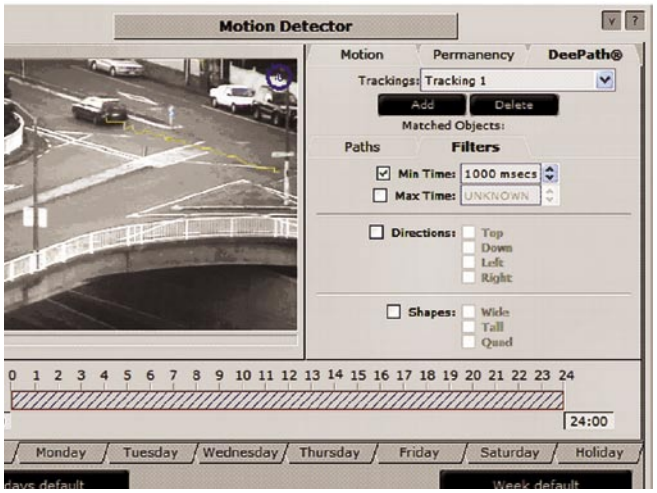
For more information, please visit www.cieffe.com or contact your nearest CIEFFE regional office. [•]



CIEFFE SPECTIVA DeePath® Paths Setup Screen, where trackings, object zones and zone steppings are configuredwhere motion detection parameters are defined for each zone



CIEFFE SPECTIVA DeePath® Paths Setup Screen with two object trackings shown



CIEFFE SPECTIVA DeePath® Filters Setup Screen, where object filters (time, direction and aspect ratio) are configured