Smart IP 네트워크 카메라의 비디오 내용 분석 서비스 설계 및 구현

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Design and Implementation of ONVIF Video Analytics Service for a Smart IP Network camera

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Abstract

ONVIF is becoming a de factor standard specification for supporting interoperability among network video products, which also supports a specification for video analytics service. A smart IP network camera is an IP network supporting video analytics. In this paper, we present our efforts in integrating ONVIF Video Analytics Service into our currently developing smart IP network camera(SS IPNC; Soongsil Smart IP Network Camera). SSIPNC supports object detection, tracking, classification, and event detection with proprietary configuration protocol and meta data formats. SSIPNC is based on TI' IPNC ONVIF implementation which supports ONVI Core specification, and several ONVIF services such as device service, imaging service and media service, but not video analytics service.

1. Introduction

Visual surveillance has always been needed for security, transparency and monitoring. It has evolved from human' s desire to monitor acquired real-time video data; and nowadays in the digital age, the next step is to proactively extract and analyse visual data contents and extract meta information for surveillance so as to reduce human interventions and management costs, and to provide proactive and real-time automatic surveillance services. Surveillance CCTV cameras or IP network cameras are the starting points for visual surveillances. We are currently developing a smart IP network camera (hereafter SSIPNC) capable of analysing video contents in real time to perform object detection, tracking, classification and various other functionalities including event detections[1]. The SSIPNC is developed so as to support its own proprietary interfaces to configure such functionalities and receive meta data from a web browser. Meanwhile, ONVIF [2] has emerged as a de-facto standard for securing interoperability between surveillance devices and systems. We have realized the need to adapt our existing implementation to the ONVIF standard to increase interoperability with other related systems and increase general adoption rate.

In this paper, we present our efforts to integrate our existing video content analytics component (VCA) into the ONVIF framework and Video Analytics Service to standardize SSIPNC' s video analytics functionalities in the international de-facto visual surveillance interoperability.

2. Backgrounds

2.1 ONVIF

ONVIF (Open Network Video Interface Forum) is an organization started in 2008 by Axis Communications, Bosch Security Systems and Sony [2]. The ONVIF specification aims to achieve interoperability between network video products regardless of manufacturer. Current version of the specification is version 2.1. The specifications consist of many parts: Core specification, Service specification, Test specification, ONVIF Conformance Process

Specification, ONVIF Web Service Definition Language (WSDL), and Extended Markup Language (XML) Schema Specifications. Core specification covers device discovery, device management, event framework. Service specifications currently cover Device IO, Media, Imaging, Receiver, Display, PTZ, Video Analytics, Video Analytics Device, Recording Control, Recording Search, Replay Control. For the details of each specification, the readers are recommended to refer to each original full version specification found in [2]. ONVIF makes use of Web services with SOAP and provides a formal conformance process, therefore assuring interoperability between products regardless of their brand.

The current ONVIF implementation on SSIPNC is based upon TI' s framework, which implemented the device service, imaging service and media service. They were implemented on a modified version of Boa web server, which directly parses request and pass them to appropriate modules without the overhead that would be there if they had used the CGI (common gateway interface) method instead. This implementation relies on the gSOAP framework [3] for SOAP request analysing and response construction.

2.2 Soongsil Smart IP network Camera(SSIPNC)

Fig. 1 shows our currently developing smart IP network camera (SSIPNC)' H/w architecture[1]. SSIPNC mainly consists of two parts, main processor part (ARM) and DSP processing part. Main processor part is centered around DM368 (ARM core + HDVICP + Video Input/Output interfaces + several peripherals) and is responsible for video capturing, video compression, networking, and other I/O functionalities, and DSP part (DM6437) is responsible for efficient processing of video content analytics(VCA). Command and response between ARM part and DSP part is done via SPI (Serial Port Interface) and ARM part passes captured video data to DSP part by DM36x' s VPBE(Video Processing Back End) and DSP part receives the passed video data via DM6437' s VPFE (Video Processing Front End).

Fig.2 shows SSIPNC' s current S/W architecture related with video content analytics[1]. As a smart video analytic application, a VCA module needs to support the following functions: remote control and configure VCA over a network, process the video intelligent analytic and do event checking base on pre-configured rule setting, export meta-data, and raise an alarm or send snapshot when configured events are detected. The S/W architecture in Fig. 2 is designed to satisfy these requirements completely. For more detailed explanations about SSIPNC' s H/W and S/W, the readers should refer to [1].

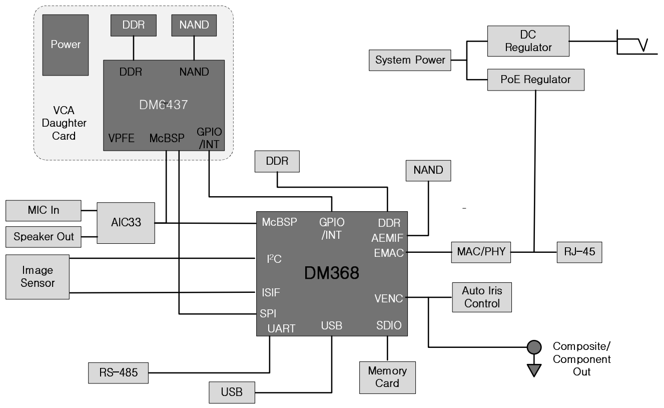

Fig.1 Soongsil Smart IP Network Camera (SSIPNC)' s Hardware architecture

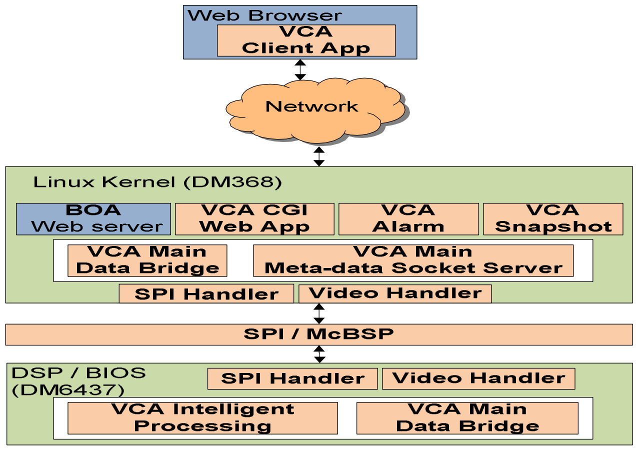

Fig. 2 Fig.1 Soongsil Smart IP Network Camera (SSIPNC)' s Software architecture mainly related with Video Content Analytics

2.3 ONVIF Video Analytics Specification

ONVIF releases Video Analytics Service specification[4]. Here, we briefly describe the main points.

Video analytic applications are divided into image analysis and application-specific parts. The interface between these two parts produces an abstraction that describes the scene based on the objects present. These two separate parts, referred to as the video analytics engine and as the rule engine, together with the events and actions, form the video analytics architecture according to this specification as illustrated in Fig. 3.

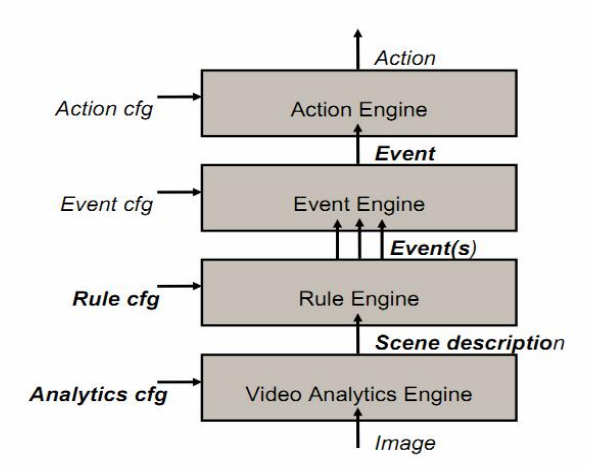

Fig. 3. ONVIF Video Analytics Architecture

The video analytics architecture consists of elements and interfaces. Each element provides a functionality corresponding to a semantically unique entity of the complete video analytics solution. Interfaces are unidirectional and define an information entity with a unique content. Only the Interfaces are subject to this specification. Central to this architecture is the ability to distribute any elements or sets of adjacent elements to any device in the network.

The ONVIF Video Analytics Service standard states that the video analytics service shall have three interfaces:

- Analytics Configuration Interface: Used to apply settings to and turning different analytic modules on and off.
- Scene Description Interface: Describe the background scenery as perceived and described by the analytics component. This includes coordinate system, reference point and translation operators.
- Rule Configuration Interface: Used to configure rules that will generate the corresponding action and trigger the event-based action mechanism defined by ONVIF. Rules also include data elements that describe them. These data elements are also common to many ONVIF components and have been defined in ONVIF core specification.

These interfaces shall be accessible via ONVIF standard SOAP protocol while UDP protocol is used for device discovery, and RTP used for media streaming.

2.5 TI's IPNC ONVIF Implementation Architecture

TI released its own ONVIF implementation for Davinci platform which supports several ONVIF services such as device IO, imaging, media as well as core specification through XML and SOAP message over HTTP protocol. SSIPNC is based on Davinci platform so that TI's ONVIF implementation can be incorporated into SSIPNC. Thus, we want to add ONVIF video analytics service onto TI's ONVIF implementation for Davinci platform where BOA web server passes ONVIF message and protocol over to ONVIF server which maps SOAP requests into proper back end processing modules. Responses for ONVIF requests return back to ONVIF clients via BOA web server. TI adopted gSOAP framework for handling SOAP protocol.

3. Proposed Design and Implementation Architecture of ONVIF Video Analytics Service for SSIPNC

3.1. Outline

Since TI's ONVIF implementation is already integrated into SSIPNC, our design strategy is basically based on modification of TI's ONVIF implementation architecture to incorporate ONVIF Video Analytics Service.

First, we generate corresponding gSOAP code for the new service. Second, we add the request handling code to the corresponding files in the existing implementation. In the process, we must also use gSOAP's envelope namespace mapping to make sure service name be consistent across modified codes and original unchanged codes. Third, we map ONVIF data types describing the parameters of ONVIF Video Analytics services to corresponding appropriate parameters of the existing SSIPNC VCA module. Fourth, we wrap the results returned from VCA module into ONVIF compatible types and continue the normal ONVIF request handling process. Mappings between SSIPNC VCA data output and ONVIF services are shown in Fig. 4. ONVIF VCA message processing working flow in a newly designed SSIPNC is illustrated in Fig. 5. In addition to returning the state, the VCA module will also stream XML metadata analysed from the input video data through RTSP implemented in ARM side so that ONVIF Video Analytics clients can utilize metadata as they want.

In software engineering, it is usually easier to isolate errors when different components of the code are separated. We reorganize the current VCA processing functionalities into three groups; analytics-related functions, alarm functions and snapshot functions. This separation is chosen due to the original intended functions of the VCA module. This modification is done without affecting the underlying processing codes and communication to the DSP-based component.

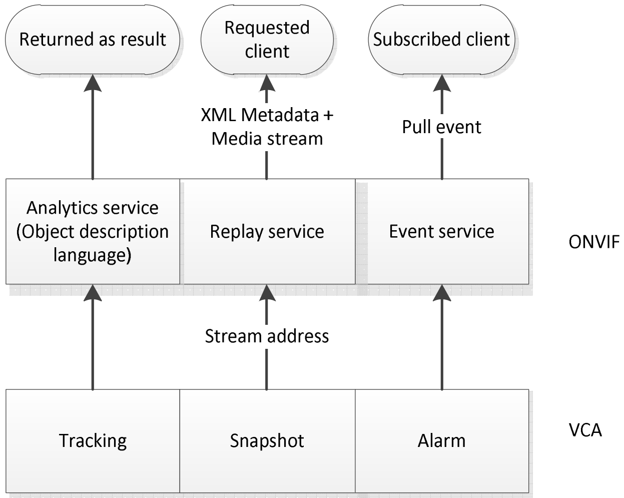

Fig 4. Mappings between SSIPNC VCA data output and ONVIF services

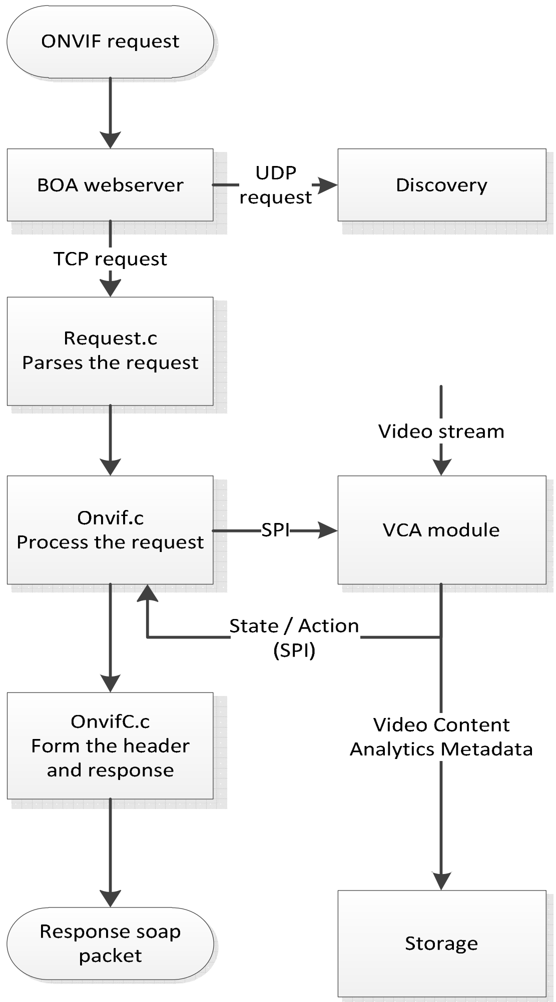

Fig. 5. ONVIF VCA Message Processing flow on SSIPNC

3.2. Data and response mapping

As our original VCA's output was only a proprietary protocol, some alterations should be made to make them usable within ONVIF's specifications. Objects identified in tracking shall be described in ONVIF analytics specification's object description language [5], snapshots captured will be stored and returned at a later time on client request via the replay service's *GetReplayUri* function, and alarm messages will be sent to the event service to notify subscribed clients in real-time.

The replay URI returned to the client will point directly to VCA's output, which is a RTSP stream with XML metadata packaged together. The client can then process this information according to its needs.

In order to achieve all the functionalities mentioned, we implement the video analytics, replay service and event service in addition to the already existing three services in the reference implementation.

4. Concluding remarks

In this paper, we have outlined the issues in supporting ONVIF Video Analytics Service specification and integrating the specification into an existing SSIPNC. Several problems and the corresponding solutions were highlighted to ease the implementation. We are confident that supporting the ONVIF standard would open new markets to our system and increase the value of the data since it can now be easily migrated to other ONVIF-compatible systems.

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[4] Open Network Video Interface Forum. ONVIF video analytics specification version 2.1.1, January 2012