A Realization Method of Video Information Exchange for Network Connected Vehicles

Deyou Zhan¹, Qingchun Jiao², Binghui Song³

¹Zhejiang Fang Yuan test group
²Zhejiang University of science & technology
³Zhejiang Uniview Technology Co., Ltd.

*Corresponding author’s e-mail: ¹24855693@qq.com, ²jiaoqch@126.com, ³song-binghui@163.com.

Abstract. This article through the design which has the function of transcoding, distribution and authentication exchange unit, achieve a face made car video information exchange method. REST method is used to realize the interface call of video information exchange, which includes control flow, media flow and structured data flow of video content analysis results. It can be used in video exchange scenarios of vehicle and vehicle, vehicle and infrastructure, vehicle and remote management platform.

1. Introduction

Intelligent transportation with modern communication technology, sensor technology and the rapid development of information processing technology has obtained the approval and carried out within a certain scope. The development of intelligent long-distance traffic scheduling, driverless vehicle interconnection, vehicle-road collaborative adaptive path planning and other technologies will greatly improve the efficiency of traffic at the same time, greatly reduce the loss. According to U.S. department of transportation estimates, the use of vehicle-to-infrastructure communications can effectively prevent 82% of accidents [1].

With the application of car video more and more abundant in recent years, the video information service in the vehicle provides a lot of content for drivers and passengers. For example multiple view road surveillance video from multiple cameras mounted on the vehicle, video shots highlighting traffic conditions on the planned route and on the highway, etc [2]. The exchange of information between the workshop video and video between the vehicle and the infrastructure and remote management platform greatly expands the perceived range. The scene model is shown in figure 1. This kind of application for multiple channel video transmission needs the support of high-speed broadband transmission. Currently, the global 5G network deployment is actively promoted, which provides a good environment for the integration of vehicle-mounted network and mobile cellular network [3]. Jie Y [4] and others think that using cellular mobile network communication as auxiliary communication architecture is the future development direction of vehicular network.
Studies have shown that video data exchanged between vehicles, between vehicles and infrastructure provides a unique opportunity to advance driver assistance applications and intelligent transportation systems (ITS) [5]. Ikeda M [6], Zaidi S [7], Wu H [8] et al studied transmission characteristics and protocols of networked connected cars (video). Video source involved in the network connected vehicle is spread out from scattered vehicles and road infrastructure, which has the characteristics of large flow of video and high temporary combination. Liu Z and Abdi L studied the outward broadcast mechanism of vehicle-mounted video facing the scene of expressway [9, 10]. The data stream transmission of networked vehicles has obvious bidirectional characteristics, and video of each mobile vehicle transmits video resources outwards relatively fixed; however, the video streams received from interested parties are uncertain. Remote management platform has obvious convergence characteristics. The realization of video exchange for network connected vehicle needs universality, flexible access, and can meet the requirements of elastic expansion and dynamic selection.

2. Video exchange structure

In order to realize establishes the video exchange system between vehicles and vehicles, road infrastructure, remote management desks. By constructing a structure based on two-way network transmission, to complete the function of real-time exchange of all parties control stream, video stream with video intelligent structured data stream. Taking minimum exchange interconnection as the research object, two nodes are designed to conduct video exchange logic structure, as shown in Figure 2.

Combine the core functional components of the node logical structure participating in the exchange to form a video exchange unit, which mainly implements functions such as authorization authentication, access and output, transcoding and distribution of video streams. Each participating exchange node includes exchange unit and management terminal of video, video resource for exchange, and security isolation device for video and data. When the two nodes are connected to each other for video exchange, the video streams, video attributes and corresponding video content intelligent analysis results structured data of their respective are sent to each other.

![Figure 1. Scene model of network connected vehicles](image-url)
Node A and node B can send video and data to each other and receive video and data sent by each other. The key step in the exchange process:

The 1st step: Nodes A and B respectively access the required camera video and structured data as video resources for exchange to form video exchange resources. Through negotiation with video resource management module, confirm the output mode to the other node; The 2nd step: Authorized video streaming and data transmission through the security isolation module, Video and data security isolation can be achieved by universal firewall and video network gate; The 3rd step (optional): If the video formats of node A and node B are not consistent, if H.265 and MPEG2 are adopted respectively, transcoding shall be carried out in their respective switching units; The 4th step (optional): When the received video stream needs to provide services to multiple video applications within the node, the service implementation is distributed through the video stream of the Video Exchange Unit (VEU).

3. Exchange protocol
The network connected vehicles involves a large number of heterogeneous devices. It is ideal to implement the control signaling stream, video stream and structured data stream all over on HTTP by using the universality features of TCP/IP and HTTP.
the corresponding video stream. The control signaling and data interface are defined by a REST-style method, and the video channel is based on RTP/RTCP and RTSP.

RESTful is a platform-independent communication protocol that enables information exchange between heterogeneous systems [11], also be used as the interface of Internet of Things and M2M [12]. It is a way to create services by abstract all information to be resources in a unified way and any information that can be named can be used as a resource. Each resource defines a required or optional query string parameter, and the query string parameter appears as a name/value pair. For example, to query the resource list, the URI is: /VRS/Query/ResList.

4. Implementation operation

4.1. General Interaction Process

According to the function role of each video exchange node is set as the resource requester and the resource provider. The general process of interaction between the nodes is the method in which the resource requester first sends Request, and then the resource provider responds to the Response message. The process is shown in Figure 3:

Figure 4 Universal interaction process

4.2. Authorization Authentication implementation

The resource requester needs to pass the authorization authentication of the resource provider to obtain the corresponding service. Authorization authentication needs to carry authentication information in every request message; otherwise the request will be rejected. Carry out information authentication in the case of carrying authentication information. When the authentication is passed, the request will be responded; when the authentication fails, the request returns an error. The process is shown in Figure 5.

Each time the resource requester requests the service, the header field of the HTTP request message shall contain the Authorization field, described as Authorization: Digest-SHA1, username="username", timestamp="create message time", nonce="random number", Response= "password summary".

Among them:

a) Digest-SHA1 is the authentication mode, and SHA1 is the digest algorithm, which is different from the Basic and Digest modes of the HTTP protocol;

b) Timestamp is the timestamp when creating this HTTP message. The format is as follows: YYYY-MM-DD Thh:mm:ss; Nonce is a 16-byte random number, represented by a hexadecimal string;

c) Response is a user password digest. The algorithm is response=SHA1 (timestamp+nonce+user+ password). The result of the digest calculation is represented by a hexadecimal string, and "+" means a string concatenation.

After receiving the Request, the resource provider sends an HTTP/1.1 401 Unauthorized response if the HTTP header field does not carry the Authorization field, or the Authorization field does not carry the complete username, timestamp, nonce, and response fields. If the header field is legal, the response value is calculated as described above, and compared with the value in the request message.
If they are the same, the authorization authentication is passed, and subsequent operations are performed; if not, the error response is sent.

In order to effectively prevent an attacker from sending a packet that the destination host has received to spoof the system, the authentication process may include the following operations:

a) The server verifies the timestamp. The difference between the time when the message is received and timestamp set an upper limit. It is recommended not to exceed 5 minutes. Otherwise, it is considered illegal and the authentication not pass.

b) Within the allowable time limit (for example, 5 minutes), the server caches the nonce value. The nonce value carried in the new message is not allowed to be duplicated with the nonce value in the cache. Otherwise, the authentications not pass.

4.3. Real-time video and formatted data call implementation

The real-time video stream call interface implements the introduction of a specified real-time video from the target node, and the request response process is as shown in Figure 6. The request URI is described as /VRS/Subscribe/RT Stream, and the signaling process is described as follows:

a) The resource request sends a call to the real-time video stream request to the resource provider;

b) The resource provider returns the live negotiation result to the resource requester according to the request and permission of the resource requester;

c) In case the request is successful, the resource provides a real-time video stream to the resource requester.

Figure 6. Real-time video stream call flow  Figure 7. Video structured data subscription process

When the video content is recognized by the intelligent analysis device, and the structured feature information of the related vehicle target and other content are saved, the structured information can be reported to the resource requester by using a specified protocol interface, and the request URI is /VRS/Subscribe/ **info, **info means that you can replace it with different video structured features to subscribe to. The process is shown in Figure 7.

5. Expectation

The video exchange requirements of the network connected vehicles are clear, and the exchange scenarios are rich. The implementation method of the video control flow and the video structured data stream call as a resource by using the REST method has good adaptability for the combination of the network connected vehicles and the internet application. On the basis of the future 5G mobile communication transmission, combined with the front-end application of artificial intelligence video analysis, through the mutual exchange of information between the rich video subjects, It will produce positive impetus effect to the deep data analysis.
Acknowledgments
The article is funded by the scientific research project "Development and Demonstration of Common Technical Standards for Intelligent Internet of Vehicles" (Program No. 20180107) of Zhejiang Provincial Market Supervision Bureau.

References:
[1] ML Sichitiu, M Kihl, Inter-vehicle communication systems: a survey. IEEE Communication Surveys and Tutorials 10(2), 88–105 (2008)
[2] Li Q, Andreopoulos Y, Mihaela V D S (2007) Streaming-viability analysis and packet scheduling for video over in-vehicle wireless networks[J]. IEEE Transactions on Vehicular Technology, 56(6):3533-3549.
[3] A Benslimane, T Taleb, R Sivaraj, (2011) Dynamic clustering-based adaptive mobilegateway management in integrated VANET-3G heterogeneous wireless networks. IEEE Journal on Selected Areas in Communications 29(3), 559–570.
[4] Jie Y, Jin W, Li W, et al. (2017) Vehicle networking data-upload strategy based on mobile cloud services [J]. Eurasip Journal on Embedded Systems, 2016(1):22.
[5] Horani M, Al-Refai G, Rawashdeh O. SAE (2017) Technical Paper Series [SAE International WCX™17: SAE World Congress Experience - , (APR. 04, 2017)] SAE Technical Paper Series - Towards Video Sharing in Vehicle-to-Vehicle and Vehicle-to-Infrastructure for Road Safety[J]. 1.
[6] Ikeda M, Honda T, Barolli L. (2015) Performance of optimized link state routing protocol for video streaming application in vehicular ad-hoc networks cloud computing.[M]. John Wiley and Sons Ltd.
[7] Zaidi S, Bitam S, Mellouk A. (2018) Hybrid error recovery protocol for video streaming in vehicle ad hoc networks[J]. Vehicular Communications, S221420961730181X.
[8] Wu H T, Horng G J. (2017) Establishing an Intelligent Transportation System with a Network Security Mechanism in an Internet of Vehicle Environment[J]. IEEE Access, PP(99):1-1.
[9] Liu Z, Dong M, Zhang B, et al. (2016) RMV: Real-Time Multi-View Video Streaming in Highway Vehicle Ad-Hoc Networks (VANETs)[C]/ GLOBECOM 2016 - 2016 IEEE Global Communications Conference. IEEE.
[10] Abdi L, Takrouni W, Meddeb A. (2017) Inter-vehicle video communications over Vehicular Ad Hoc Networks[C]/ 2017 13th International Wireless Communications and Mobile Computing Conference (IWCMC). IEEE.
[11] He R Y. (2014) Comparison Analysis of RESTful and SOAP-WSDL Applied in the Image Management System[J]. Applied Mechanics and Materials, 644-650:4.
[12] Dissegna M, Manfrin R, Rotoloni M, et al.(2015) RAL: a RESTful M2M communications framework for IoT[C]/ 2015 International Wireless Communications and Mobile Computing Conference (IWCMC). IEEE.