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Message from R-Letter Director

Welcome to the third issue of IEEE MMTC Review-Letter (R-Letter) in 2012. With all MMTC members' great support and all editors' great efforts, we have successfully set up a platform to deliver the latest multimedia communication technologies. We hope that the readers enjoy and benefit from every issue of the R-letter in the past two years.

In this issue, we are pleased to introduce eight high quality papers, spanning a wide range of important and hot topics, namely, video streaming, 3D object retrieval, human visual system based processing, communication technology and security. The first paper, published in the *IEEE Journal on Selected Areas in Communications*, proposes a new cooperative popular content distribution framework in vehicular networks. The second paper, *Transactions on Circuits and Systems for Video Technology*, exploits distributed peer-assisted repair protocol and demonstrates the effectiveness in IPTV multicasting scenario. The third paper, from the *IEEE Transactions on Networking*, studies joint optimization of scalable video coding, adaptive modulation and coding, and wireless multicast for heterogeneous wireless devices. The fourth paper, from *IEEE Transactions on Vehicular Technology*, investigates a new scalable modulation scheme via a software bit remapping to efficiently transmit scalable video streams. The fifth paper, published in the *IEEE Transactions on Multimedia,* proposes a 3-D object retrieval method via an intelligent query view selection with user's relevance feedback. The sixth paper, published in the *IEEE Transactions on Multimedia*, examines a new saliency detection model based on the human visual sensitivity and the amplitude spectrum of quaternion Fourier transform. The seventh paper, published in the *IEEE Transactions on Wireless Communications*, focuses on the joint designs of precoding and decoding matrices for MIMO transceiver in cognitive radio networks. The last paper, from *IEEE International Conference on Communications*, analyzes the stealthy SIP flooding attack and proposes to adopt a wavelet-based technique to quickly detect the attacks.

I would like thank all the editors of this issue for their great work: Ai-Chun Pang, Carl James Debono, Cheng-Hsin Hsu, Hassan Mansour, Vladan Velisavljević, Tao Liu, Jong-Seok Lee, and Walid Saad. I also would like to thank the R-Letter Co-Director Nabil J. Sarhan for all his great efforts in the past two years. And we also thank the MMTC chair, Haohong Wang for his unique insight and great passion to propose and support the MMTC R-Letter platform.

Guan-Ming Su

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Towards Efficient Cooperative Content Distribution for Vehicular Networks

A short review for "CodeOn: cooperative popular content distribution for vehicular networks using symbol level network coding"

Edited by Ai-Chun Pang

M. Li, Z. Yang and W. Lou, "CodeOn: Cooperative Popular Content Distribution for Vehicular Networks using Symbol Level Network Coding," IEEE Journal on Selected Areas in Communications, vol. 29, vo. 1, Jan. 2011.

Vehicular ad hoc network (VANET) is an emerging network platform which is formed by vehicles equipped with on-board wireless transceivers and communicates with each other using IEEE 802.11p standard. It has been envisioned to provide numerous tempting applications, ranging from safety warning, and intelligent navigation to mobile infotainment [1]. A particularly promising type of application is the dissemination of large multimedia contents to vehicles inside a geographical area of interest (AoI) by road side infrastructure, called "popular content distribution (PCD)", such as real-time traffic information, GPS map updates, and commercial video ads. These contents can be the key for the success of both safety-related and commercial services. However, it is fundamentally challenging to provide high speed PCD in VANETs, due to the following: 1) The large size of the content and high downloading rate/low delay demand. Typically, one piece of multimedia file can be as large as 10 ~ 100MB. 2) The highly dynamic topology of vehicular ad hoc network (VANET) and the lossy nature of the vehicular wireless communications, which causes notoriously heavy packet losses and collisions. In the literature, some existing works studied the content downloading problem in VANETs [2-4], and adopted network coding (NC) to enhance throughput. However, most of them employ a pull-based cooperative content downloading approach, which is not efficient for PCD because all vehicles will request for same contents, where the transmission coordination becomes a difficult issue.

In this paper, the authors tackle this problem by exploring a new concept symbol-level network coding (SLNC) [5] for cooperative PCD in VANETs. In contrast with traditional packet level network coding, SLNC performs network coding on finer granularity of physical layer symbols. Using a three-node simple example, the authors first show theoretically why and how SLNC can enhance error tolerance and throughput compared with PLNC. But to design a full SLNC-based PCD protocol for dynamic and large-scale VANET still involves a set of non-trivial challenges, especially how to make the most use of SLNC without incurring an overwhelming coding overhead.

Thus, the authors' primary contribution is to propose a new push-based PCD protocol, where the popular contents are actively broadcasted from a few road-side APs to all vehicles within an AoI, through the cooperation of a set of dynamically selected relay nodes. The usefulness of every piece of content broadcasted by those relays is maximized via a careful selection mechanism. In particular, before transmission, every node computes its own utility based on neighbors' reception status information (derived from the rank of the decoding matrices). The utility reflects the total amount of useful content that a node can provide to all of its neighbors. Node's priority is assigned accordingly which enhances both the downloading rate and protocol efficiency.

To reduce the protocol overhead without degrading the performance, the authors first propose a "piece-division, run-length SLNC" method, which essentially achieves higher network coding gain keeps the size of coding vectors for each piece of content low. In addition, they also present a scalable and efficient average rank method for vehicles to represent and exchange their content reception status under SLNC. By taking advantage of the multi-channel property of VANET, vehicles piggyback this tiny information in their safety messages sent in control channel, which incurs zero overhead for content downloading.

Furthermore, the authors gracefully solve the complex transmission coordination issue among potential relays using a simple carrier-sense mechanism. Each node computes a backoff delay that is inversely related to its utility, and upon the

expiration of the delay it will sense the channel. If it cannot detect signal energy, it will broadcast coded contents without delay. Otherwise, it remains silent throughout the time slot. The authors show that by exploiting the SLNC's better error tolerance, this aggressive way of channel access, although simple, can achieve close to maximum overall downloading rate.

Using extensive NS-2 simulations under both highway and urban scenarios, the proposed protocol, CodeOn is compared with a variant of CodeTorrent, a state-of-the-art pull-based, network coding based content distribution protocol. Results show that CodeOn performs significantly better than CodeTorrent, in terms of average downloading delay, protocol efficiency and fairness. Significant improvements in average downloading rate are obtained for both highway and urban scenarios. Through a decomposition analysis, it is shown that one part of the gain comes from the use of SLNC, and the other important part is attributed to the new push-based protocol design.

CodeOn is a promising scheme for push-based popular content distribution in vehicular networks. It uses symbol-level network coding (SLNC) to combat the lossy wireless transmissions resulting from the time-varying fading channel conditions in VANET. Several key novel methods are proposed to enhance the protocol efficiency without sacrificing the coding gain of SLNC. In summary, this work demonstrates the strong potential to achieve fast PCD in realistic vehicular networks, under dedicated short range communications (DSRC) and IEEE 802.11p. The success deployment of PCD technique will greatly contribute to reliable safety-related and commercial services in vehicular networks.

References:

[1] "Dedicated Short Range Communications," http: //www.standards.its.dot.gov/Documents/advisories /dsrc advisory.htm

[2] U. Lee, J.-S. Park, J. Yeh, G. Pau, and M. Gerla, "Code torrent: content distribution using network coding in vanet," in *MobiShare* '06, 2006, pp. 1–5.

[3] J.-S. Park, U. Lee, S. Y. Oh, M. Gerla, and D. S. Lun, "Emergency related video streaming in vanet using network coding," in *ACM VANET* '06, 2006, pp. 102–103.

[4] S.-H. Lee, U. Lee, K.-W. Lee, and M. Gerla, "Content distribution in vanets using network coding: The effect of disk i/o and processing o/h," in *IEEE SECON* '08, June 2008, pp. 117–125.

[5] S. Katti, D. Katabi, H. Balakrishnan, and M. Medard, "Symbol-level network coding for wireless mesh networks," *ACM SIGCOMM Comput. Commun*. Rev., vol. 38, no. 4, pp. 401–412, 2008.

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Peer-Assisted Error-Control in IPTV Multicast Networks

A short review for "IPTV multicast with peer-assisted lossy error control"

Edited by Carl James Debono

Z. Li, X. Zhu, A. C. Begen, and B. Girod, "IPTV Multicast with Peer-Assisted Lossy Error Control," IEEE Trans. on Circuits and Systems for Video Technology, vol. 22, no. 3, pp. 434 – 449, March 2012.

Today's Internet Protocol Television (IPTV) technology can exploit IP multicasting [1] techniques to provide a scalable solution capable of distributing large-scale television services over packet-switched networks. In an IPTV distribution system, Digital Subscriber Line (DSL) links often connect the network and the end-user locations. Beside television broadcast, DSL can provide other services, such as Internet access and voice services (VoIP). However, DSL links are vulnerable to various types of interference, among which the impulse noise has the most devastating impact on the quality of the received video stream [2]. To mitigate these effects, current IPTV deployments complement multicast with a hybrid error-control mechanism, combining multicast Forward Error Correction (FEC) and unicast retransmissions of corrupted packets. Retransmitted packets are generated by unicast servers, which are usually located at the edge of the core network. Because of their unicast nature, these servers can quickly saturate and become a bottleneck as the system scales up to support increasing numbers of downstream receivers.

In their paper, the authors proposed an alternative solution to overcome the effect of this bottleneck. They base their reasoning on the insight that the unicast servers are not the only resource in the network that can provide a copy of the missing video packets. Within the IP network, the same video stream is also cached by the peer receivers of the same multicast session. Therefore, the unicast service can be partially shifted from the dedicated servers to the multicast peer receivers. This architecture is in line with the Peer-to-Peer (P2P) paradigm, which has enjoyed wide popularity over the last decade. In doing so, the authors are exploiting the peers to improve error resiliency with minimal increase in bandwidth requirements.

One of the important technical challenges addressed in this work is the development of a reliable error-control service from the unreliable peers. Peer receivers, unlike dedicated servers, can join/depart a multicast session at any time, increasing churn. Things become more complex if the error-control service needs to be delivered within a strict deadline. In their proposed Peer-Assisted Repair (PAR) protocol, the authors address this issue in two different aspects. First, they introduce redundancy in the peer retransmission packets via coding. The coding rules are specified in the request packets and sent to the peers, which enable distributed generation of parity packets at the peer end. These generated packets are sent to the target receiver. At the target receiver side, as long as enough parity packets are received, even if some peers have departed, the receiver can perform decoding to recover the requested packets. Second, in the event that too many peers become unreliable, the scheme falls back to the original server-based error-control system. Thus, the unicast servers would only serve as the last resort when the peer-assisted service becomes unavailable.

The second part of the proposed scheme is on the combination of the PAR protocol with an application-layer error protection scheme, named forward and retransmitted Systematic Lossy Error Protection (SLEP/SLEPr) [3], [4]. The resulting joint PAR-SLEP/SLEPr framework offers additional improvement with respect to the PAR alone. First, it offers stronger error protection against impulse noise. This is implemented by reducing the size of the parity packets at the expense of a slight drop in video quality, to save some room for a stronger error protection scheme. The aggregate effect is that it can avoid the "cliff effect" (i.e., the error correcting performance undergoes a sharp degradation at some threshold) that is usually experienced in conventional FEC. Second, the reduction of the parity packet size can also effectively avoid link congestion at the peer downlink due to redundant parity packet retransmission. Third, the impulse noise and the peer departures can be treated within a unified framework, leading to a more effective error-control scheme.

The performance gain that is achieved by the proposed framework has been analyzed by the authors through both mathematical analysis and simulation results. They show that, counter-intuitively, as the system scales up (i.e. the number of supported receivers increases), when more peers become available, the load on the unicast server actually drops. This is in contrast to a pure server-based scheme, where the server load increases linearly with the number of receivers. The authors conclude that some small amount of peer uplink bandwidth, which is the extra cost needed to support peer assistance, is sufficient to support a viable system deployment. Other aspects of this framework, such as the video quality delivered, response to correlated loss and end-to-end delay were also validated through simulation results.

Peer-to-peer networks solutions, although originally intended for file sharing, have been used for video streaming and thus the potential of using this technology for error resiliency provides an open area of research [5], [6]. The authors have provided a useful aspect of applying peer assistance in multicast error control for scalability and reliability in IPTV distribution systems. This solution is attractive as it requires only a small increase in bandwidth whilst providing lower end-to-end delays, compared to the legacy systems. Furthermore, the solutions proposed in this work can be applied in a broader class of applications involving multiple receivers, such as multi-party audio or video conferencing, network gaming and online whiteboarding, where both delay and reliability are crucial in providing an acceptable quality to the user experiences.

References:

[1] S. Deering, "Multicast routing in a datagram internetwork," Ph.D. Thesis, Stanford University, Dec. 1991.

[2] A. Begen, "Error control for IPTV over xDSL networks," in *Proc. IEEE Consumer Communications and Networking Conference*, 2008, Jan. 2008.

[3] S. Rane, P. Baccichet, and B. Girod, "Systematic lossy error protection of video signals," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 18, no. 10, pp. 1347-1360, Oct. 2008.

[4] Z. Li, X. Zhu, A. Begen, and B. Girod, "Forward and retransmitted Systematic Lossy Error Protection for IPTV video multicast," in *Proc. Packet Video Workshop* 2009, May 2009.

[5] D. Tsang, K. Ross, P. Rodriguez, J. Li, and G. Karlsson, "Advances in peer-to-peer streaming systems," *IEEE J. Select. Areas Communications*, vol. 25, no. 9, pp. 1609–1611, Nov. 2007.

[6] X. Zhang, J. Liu, and T.-S. P. Yum, "Coolstreaming/DONET: A data driven overlay network for peer-to-peer live media streaming," in *Proc. IEEE INFOCOM*, Mar. 2005, pp. 2102–2111.

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Optimizing Quality for Wireless Video Mutlicast

A short review for "Scalable video multicast with adaptive modulation and coding in broadband wireless data systems"

Edited by Cheng-Hsin Hsu

P. Li, H. Zhang, B. Zhao, and S. Rangarajan, "Scalable Video Multicast with Adaptive Modulation and Coding in Broadband Wireless Data Systems," IEEE/ACM Trans. on Networking, vol. 20, no. 1, pp. 57– 68, Feb. 2012.

Although modern mobile wireless networks achieve increasingly higher spectrum efficiency and thus network capacity, mobile Internet traffic grows at an even higher rate. Cisco reports that the number of mobile devices will exceed the number of people on the earth by the end of 2012, and the mobile Internet traffic amount will increase 18 times between 2011 and 2016 [1]. Given that the wireless medium is shared among all users, how to allocate network resources among individual users remains an important issue.

Among various bandwidth-hungry services over mobile wireless networks, large-scale video streaming, also known as mobile TV, is probably the most challenging one for two reasons. First, video streams consume a lot of bandwidth, even after compression. Second, some wireless networks only support unicast, which leads to tremendous amount of redundancy in the transmitted data streams, especially when many viewers watch the same video. Excessive resource consumption due to video streaming may degrade the Quality-of-Service of other services. Therefore, how to efficiently implement large-scale video streaming services is critical.

This paper considers a better large-scale video delivery approach, which capitalizes the broadcast nature of wireless medium and multicasts each video only once to all the viewers. More specifically, the authors encode every video into a scalable video stream with multiple layers. Each layer is multicast to a subset of viewers so as to maximize the overall video quality. As in many other wireless networks, each viewer may experience different channel conditions, and thus could reliably receive at diverse channel rates. The considered system takes the channel rates of individual viewers as inputs, and decides how many layers should be sent to each viewer. Both single and multiple video scenarios are considered in this work.

The room for optimization comes from a trade-off between: (i) the channel rate and (ii) the number of viewers who can receive at that rate. More precisely, each video layer can be multicast with a different Modulation and Coding Scheme (MCS). An aggressive MCS achieves high channel rate. However, it requires good channel condition for decoding, and thus only works for fewer viewers, say those close to the cellular towers. In contrast, a robust MCS delivers a video layer to more viewers, but suffers from lower channel rates.

The authors combine the abovementioned trade-off with scalable video streams into a resource allocation problem, in which a very general utility function is employed. In particular, both viewer- and session-dependent utility functions are possible, and the authors only assume that the utility function is non-decreasing and positive. Moreover, different video layers may have diverse bit rates. Finally, unlike Deb et al. [2], the authors do not specify a minimum bit rate to all viewers for the basic video quality. The authors prove this problem is NP-Hard, and formulate it into an Integer Programming problem.

The authors propose two optimal algorithms to solve the single- and multiple-video problems. Both algorithms are based on dynamic programming, and run in pseudo-polynomial time. The complexity of the single-video algorithm is $O(JL+LM^2T)$, where J is the number of viewers watching this video, L is the number of layers, M is the number of MCSs, and T is the number of slots in each wireless frame. The complexity of the multiple-video algorithm is $O(LJ+SLM^2T+ST^2)$.

The proposed algorithms are evaluated using simulations, and compared against the greedy algorithm proposed in [2] and a baseline algorithm. With real SVC videos, the proposed algorithm outperforms the baseline algorithm by up to 9 dB, and the greedy algorithm by up to 4.3

dB. The simulations also reveal that the proposed algorithms adapt to viewer mobility: the video quality only slightly drops even when viewers constantly roam around and switch among videos.

I found that the general optimization framework used in this paper could be extended in a few directions. First, the framework doesn't take the energy consumption of mobile devices into considerations, while mobile devices are energy-limited. A resource allocation algorithm that jointly considers shared network resources and individual energy resources may better promote video multicast services to general publics. This is because voice communication is still the most critical functionality of most mobile devices, and users don't want to fully deplete their batteries for video streaming services. Second, while the proposed algorithms achieve pseudo-polynomial running time, such time complexity might be still too long in real systems. More experiments, ideally in real testbeds, are required to validate the practicality of the algorithms in real-time systems. Last, the two proposed algorithms assume scalable videos are linearly encoded into a base layer and several enhancement layers. However, with modern scalable video coders, each video can be encoded with multiple, temporal, spatial, and fidelity layers. Multi-dimensional stream adaptations with arbitrary combination of frame rates, resolutions, and fidelity levels are possible. Extending the algorithms to cover these flexible adaptations is also an interesting task.

References:

[1] Cisco visual networking index: Forecast and methodology, 2011–2016.http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf.

[2] S. Deb, S. Jaiswal, and K. Nagaraj, "Real-time Video Multicast inWiMAX Networks," in Proc. *IEEE INFOCOM*, 2008, pp. 1579–1587

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Differentiated Service in Wireless Video: Scalable Modulation Approach

A short review for "Scalable modulation for video transmission in wireless networks"

Edited by Hassan Mansour

L. Cai, S. Xiang, Y. Luo and J. Pan, "Scalable Modulation for Video Transmission in Wireless Networks," IEEE Trans. on Vehicular Technology, vol. 60, iss. 9, pp 4314 – 4323, Nov. 2011.

With the improvement of the bandwidth and reliability provided in the wireless network, video mobile services have gained a lot of attention and are anticipated to be a major revenue generator for the whole ecosystem. On the other hand, due to the high and fluctuated data rate of video traffic and the time-varying and location-dependent wireless channel characteristics. it becomes a very challenging problem for efficient video streaming over wireless networks. The research reported in this work sheds new lights on this challenging issue.

The physical (PHY) layer in existing systems mainly focuses on how to efficiently transmit information bits to approach the channel capacity, using the adaptive modulation and coding (AMC) scheme. The traditional AMC scheme is not suitable for multicast or broadcast video transmissions as getting real-time feedback from multiple receivers requires high overheads; also, different users have different channel conditions, and they may prefer different modulation and coding schemes from the same transmitter from time to time.

In addition, the traditional PHY layer assigns equal priority for every bit from the upper layer. In other words, the PHY layer uses the same amount of resources to transmit each bit. As the video bit streams consist of syntaxes depending on prior correctly decoded bits, different portions of the same traffic flow will exhibit different importance and have different impact on the user-perceived quality of service (QoS). For instance, for a typical MPEG video, I frames are much more important than B and P frames. For scalable video coding (SVC) [1], the video streams are encoded into a base layer and some enhancement layers. As the decoding of enhancement layer relies on the success of decoding the base layer, the packet losses in the base layer have much severer QoS degradation than those in the enhancement layers.

In the past decades, a tremendous volume of work has been made in network protocol design focusing on how to provide differentiated services. However, it is still an open research problem regarding how to fine-tune the PHY layer, particularly the modulation scheme, to more efficiently support layered scalable video. it was shown that SuperPosition Coding (SPC) and its implementation (so-called hierarchical modulation or h-mod) have been considered as a promising candidate for video multicast [2][3]. The drawback of the SPC scheme is that it requires more complicated hardware, which increases the cost of deploying 3G/4G networks. Besides the hardware issues, the algorithm and software need to address the cross-layer optimization problem, including the configuration of the PHY-layer modulation and coding schemes, to maximize the utility of scalable video multicast.

To tackle the aforementioned issues, the authors propose and design scalable modulation (s-mod) schemes to provide differentiated services to upper layer data streams. The proposed scheme can ensure the minimum video quality and can be deployed using the existing quadrature amplitude modulation (QAM) modem. As a software-based approach, the s-mod schemes just redefine (or remap) the constellation points of the existing QAM to modulate and demodulate the layered bits with different bit error probabilities (or bit error rate, BER). The simplicity and flexibility of the software-approach makes s-mod not only ready to implement, but also achieve even better performance than h-mod.

The authors also formulate the proposed system as a cross-layer optimization problem to maximize the profit of scalable video multicast and unicast by selecting the configuration of the PHY-layer s-mod and coding schemes.

The authors also conduct extensive simulations with real videos and realistic wireless channel profiles to evaluate the performance of different modulation schemes. Simulation results demonstrate substantial performance gains using

s-mod and cross-layer optimization, indicating that s-mod and SVC are a good combination for video transmission in wireless networks.

References:

[1] H. Schwarz, D. Marpe, and T. Wiegand, "Overview of the scalable video coding extension of the H. 264/AVC standard," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 17, no. 9, pp. 1103–1120, Sep. 2007

[2] T. Cover, "Broadcast channels," *IEEE Trans. Inf. Theory*, vol. IT-18, no. 1, pp. 2–14, Jan. 1972.

[3] S. Wang and B. K. Yi, "Optimizing enhanced hierarchical modulations," in *Proc. IEEE GLOBECOM*, Nov./Dec. 2008.

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A Discriminative View Selection Algorithm for Efficient 3D Object Retrieval

A short review for "Less is more: efficient 3-D object retrieval with query view selection"

Edited by Vladan Velisavljević

Y. Gao, M. Wang, Z.-J. Zha, Q. Tian,Q. Dai, N. Zhang, "Less is More: Efficient 3-D Object Retrieval with Query View Selection," IEEE Trans. on Multimedia, vol. 13, no. 5, pp. 1007– 1018, Oct. 2011.

The emerging advances in computer technology, graphics software and hardware and networking have led to an increasing demand for 3D shape modeling. This field is exploited in a variety of applications, like medical visualization, 3D graphics, architectural design, etc., where different 3D models have been analyzed. For these applications, effective and efficient 3D object retrieval algorithms are very important.

In recent years, extensive research efforts [1, 2] have been dedicated to view-based 3D modeling methods due to its flexibility in 3D object description by multiple views. Wide and easy availability of mobile device cameras makes it easy to capture photos and videos of real objects from different viewpoints, which further enhance the importance of view-based object retrieval methods.

The key issue in view-based 3D object retrieval is the trade-off between the effective object description and computational efficiency. An increasing number of captured views enables a better retrieval with more precise representation of the object information. However, that also carries an increase in computational complexity and cost. By contrast, using fewer views leads to a more efficient processing, but at the cost of lower accuracy.

Early methods [3] employed all the captured views for search, which is time-consuming. Recently, most existing methods performed either unsupervised view clustering [4] or view acquiring direction selection [5, 6] to select a group of representative views. This process can effectively reduce the number of views. It is noted that these methods select representative views under the criteria of completeness, i.e., the selected views should describe the whole information of the object.

However, for 3D object retrieval, the major challenge for view-based object description is discriminative rather than completeness: the selected views should discriminate the query object from other objects in the scene. To tackle this challenge, the authors proposed an intelligent query view selection method by taking into account user's relevance feedback information. The proposed method can reduce the computational cost, while improving the retrieval accuracy.

Two important features play the key roles in the proposed method. First, to explore the discriminative information of the query object, representative views are incrementally selected in an interactive scheme so that they contribute most to discrimination between the query object and user labeled objects. Such a selection of the representative views is capable of selecting the "best" from existing views to enhance the quality of object representation. The number of selected views is arbitrarily set by users without a need to pre-define it. Second, all the views are compared and selected using a chosen distance metric and corresponding weights. The iterative selection process leads to a small subset of views that can well describe the query object and discriminate it from other objects.

For 3D object retrieval, this method can effectively reduce the number of views for 3D object description, and significantly improve the retrieval efficiency. The selected representative views can also discriminate the query object effectively, which guarantees the retrieval accuracy.

This method has been evaluated on the NTU, ETH and SHREC2009 datasets. The experimental results demonstrate that this method can simultaneously improve both the retrieval accuracy and efficiency. The case with only 2 to 3 selected representative views outperforms that when all views are used. Furthermore, the computational cost can be significantly reduced resulting in even up to ten times faster execution than the case with all views.

Interesting directions for future work include exploring prediction methods for estimation of

the next best view selection acquired from the existing search results. This is important to further reduce the computational and data storage cost.

References:

[1] A. Bimbo and P. Pala, "Content-based retrieval of 3D models," *ACM Transactions on Multimedia Computing, Communications, and Applications*, vol. 2, no. 1, pp. 20–43, 2006.

[2] B. Bustos, D. Keim, D. Saupe, T. Schreck, and D. Vranic, "Featurebased similarity search in 3D object databases," *ACM Comput. Surv.*, vol. 37, no. 4, pp. 345–387, 2005.

[3] D. Y. Chen, X. P. Tian, Y. T. Shen, and M. Ouhyoung, "On visual similarity based 3D model retrieval," *Comput. Graph. Forum*, vol. 22, no. 3, pp. 223–232, 2003.

[4] T. F. Ansary, M. Daoudi, and J. P. Vandeborre, "A Bayesian 3D search engine using adaptive views clustering," *IEEE Transactions on Multimedia*, vol. 9, no. 1, pp. 78–88, 2007.

[5] P. Daras and A. Axenopoulos, "A 3D shape retrieval framework supporting multimodal queries," *International Journal of Computer Vision*, vol. 89, no. 2, pp. 229–247, 2010.

[6] J. L. Shih, C. H. Lee, and J. T. Wang, "A new 3D model retrieval approach based on the elevation descriptor," *Pattern Recognition*, vol. 40, pp. 283–295, 2007.

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Better User-Centric Visual Signal Manipulations by Visual Saliency Detection

A short review for "Bottom-up saliency detection model based on human visual sensitivity and amplitude spectrum"

Edited by Tao Liu

Y. Fang, W. Lin, B. Lee, C. Lau, Z. Chen, and C. Lin, "Bottom-up Saliency Detection Model Based on Human Visual Sensitivity and Amplitude Spectrum", IEEE Trans. on Multimedia, vol. 4, iss. 1, pp. 187– 198, Feb. 2012.

Computational saliency detection models can be used widely in many multimedia applications of segmentation, coding, transmission, retrieval, adaptation (for mobile communications and cloud computing), understanding, graphics, quality evaluation, and so on (see [1, 2] for some more discussion). When observers look at a natural or generated scene, the selective attention mechanism in the human visual system (HVS) will allocate more processing resources to the most attractive regions, rather than cross the board for the entire scene [3]. By taking advantage of this unique property, newly developed multimedia applications and services can not only effectively saving computation and hence increase the processing speed, but also provide better multimedia experience to human consumers. Currently, various computational saliency detection models have been proposed, but most of them neglect some key characteristics of the HVS, such as the human visual sensitivity change due to foveation (i.e., the influence of an image feature with the increase of the spatial distance). In addition, there is still lack of systematic means to capture all relevant low-level features for bottom-up saliency detection models (i.e., intensity, color and orientation).

This paper proposes a novel saliency detection model based on the Fourier Transform (which is general and systematic for signal analysis and can be implemented efficiently) and the principles of human visual sensitivity variations due to foveation. The amplitude spectrum of the Quaternion Fourier Transform (QFT) [4] is adopted to represent the color, intensity and orientation distributions for image patches. The saliency value of each image patch is measured through evaluating the differences (or contrast) of color, intensity and orientation distributions between this image patch and all other patches in the whole image.

Visual attention is all about the feature contrasts, not the absolute features. For example, a colorful flower is outstanding only if surrounded by green leaves; if a scene is full of flowers with similar color and shape, not a single flower stands out. If we investigate further, we find that both the distribution and relative distance of different visual objects in the scene matter. This is due to the foveation effect, which can cause human visual sensitivity to drop fast away from the attention center. Unlike the most existing methods which only consider local contrast or global contrast [5, 6], this study exploits both local and global contrast by taking into account the differences in the QFT amplitude spectrum between each individual small patch and all the other patches in the image. The selection of patch size and multi-scale operations also considers the characteristics of the HVS. In addition, the contributions of these differences to the saliency values of image patches are found to be different, and their corresponding weights are determined by the foveation-tuned human visual sensitivity.

The proposed model is validated with a public image database including 5,000 images with the ground-truth labeled by 9 subjects [7]. The experimental results show a superior performance over other state-of-the-arts in predicting the ground truth of human-labeled salient objects, which is supported by better Precision, Recall and F-Measure values. Furthermore, the authors explored the application of the proposed model in image retargeting. The proposed method is used to help extract the salient regions for images as the user-centric guide for image resizing, which is crucial in mobile media delivery and cloud computing due to the diversified requirements in bandwidths and display resolutions of client terminals.

In summary, this paper presents a novel and accurate saliency detection model based on both local and global feature contrasts, the human visual sensitivity and QFT amplitude spectrum. Another contribution of this paper is that it

demonstrates with an example how to use the detected saliency for an image segmentation application. It has already been shown that saliency is one of the essentials in many visual applications, and it is believed that it could possibly benefit an even broader range of researches in the area of multimedia communications.

The source code of the proposed method can be found in the authors' websites (https://sites.google.com/site/leofangyuming/Home/saliencydetection) for result verification, further research and benchmarking in the research community.

References:

[1] A. Borji, L. Itti, "State-of-the-art in Visual Attention Modeling," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 05 April 2012. <http://doi.ieeecomputersociety.org/10.1109/TPAMI.2012.89>.

[2] W. Lin, C.-C. Jay Kuo, "Perceptual Visual Quality Metrics: A Survey", *J. of Visual Communication and Image Representation*, Vol 22(4), pp. 297-312, May 2011.

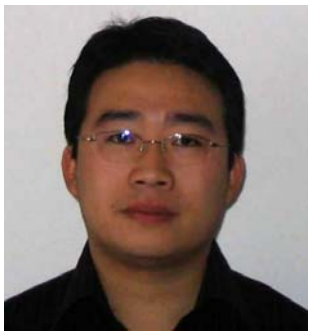
[3] H. Pashler, (Ed.) Attention, Hove, England: Psychology Press, 1988.

[4] T. Ell and S. Sangwin, "Hypercomplex Fourier Transforms of Color Images," *IEEE Transactions on Image Processing*, 16(1):22-35, 2007.

[5] L. Itti, C. Koch and E. Niebur, "A model of saliency-based visual attention for rapid scene analysis," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 20(11), 1254–1259, 1998.

[6] X. Hou and L. Zhang, "Saliency Detection: A spectral residual approach," *IEEE International Conference on Computer Vision and Pattern Recognition*, 2007.

[7] T. Liu, J. Sun, N. Zheng, X. Tang and H. Y. Shum, "Learning to detect a salient object," *IEEE International Conference on Computer Vision and Pattern Recognition*, 2007.



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Multiple Antennas Cognitive Radio Networks: Spatial Sensing and Transceiver

A short review for "MIMO transceiver designs for spatial sensing in cognitive radio networks"

Edited by Jong-Seok Lee

K. Lee, C.-B. Chae, R. W. Heath, Jr., and J. Kang, "MIMO Transceiver Designs for Spatial Sensing in Cognitive Radio Networks", IEEE Trans. Wireless Communications, vol. 10, no. 11, pp. 3570– 3576, Nov. 2011

With the increasing demand for wireless spectrum, the spectrum availability is decreasing rapidly while most of the allocated spectrum is not frequently utilized. To improve inefficient spectrum usage, the cognitive radio network has been proposed where it allows a coexistence of unlicensed users in the same spectrum for legacy users. Among many research topics regarding cognitive radio network, the underlay approach aims at reusing the spectrum by imposing interference constraint to the secondary network not to cause harmful interference to the primary network. Providing reliable communication via underlay cognitive radio, however, is known to be challenging since the maximum transmitted power of the secondary network is limited in order to protect the primary networks. In [1-3], to improve the achievable rate of the secondary network, the cognitive radio network with multiple antenna nodes has been proposed. In particular, the authors in [1-3] introduced the usage of multiple antenna nodes for the secondary network where the interference to the primary network can be managed efficiently via multiple antenna techniques while supporting reliable communications for the secondary network.

In the cognitive radio networks, to prevent interference to the primary networks, the secondary networks require to maintain a given interference constraint. The authors in [1-3] introduced the design of precoding matrices at the secondary transmitter to protect the primary networks from the interference due to the secondary transmission while maximizing the achievable rate of the secondary networks. In practice, however, since primary nodes also transmit a signal simultaneously, the primary's signal interrupts reception of the secondary data at the secondary receiver and degrades the performance of the secondary networks. In the reviewed paper, to resolve this problem, the authors proposed joint transceiver algorithms, i.e., joint designs of precoding and decoding matrices. In particular, they studied designs of the precoding matrix that is for preventing the primary receivers from the interference by the secondary transmission, and the decoding matrix that is for overcoming the performance degradation due to the primary transmission at the secondary receiver. To manage the interference, the authors utilized the projection matrix that projects the transmitted or received signal onto the null space of the desired space. Three joint algorithms have been proposed depending on the amount of channel side information (CSI) at the secondary nodes. Based on the projection matrix to satisfy the interference constraint, projected-channel singular value decomposition (P-SVD) in [3] was employed in a local CSI scenario and joint design with full CSI was proposed in a global CSI scenario. To overcome the feedback overhead to achieve global CSI, the authors proposed a new scenario, local CSI with side information, where the secondary network uses a dedicated pilot [4]. In the scenario, the secondary transmitter and receiver update precoding and decoding matrices based on the result of the previous iteration. The interesting point of the reviewed paper is that the authors derived a converged solution of the iterative algorithm mathematically by using properties of the projection matrix. The key issues of the iterative algorithm are (1) how fast the iterative algorithm converges and (2) whether the iterative algorithm always converges. Theorem 1 showed that the converged solution of the iterative algorithm approaches the solution of global CSI, and provided the condition of the convergence and the speed of the convergence mathematically.

The significance of this paper is to provide a joint solution unlike previous studies considering only design of the transmitter. The authors in [5] studied a similar problem when the number of antennas of the secondary transmitter is limited to two. In the reviewed paper, the authors generalized the solution and provided extensive studies with various CSI scenarios. In addition, mathematical derivation for the iterative solution gives readers reliability regarding the results.

As future work, the presented work could be extended to design of cognitive radio networks with different channel knowledge assumptions and to overcome the dimensionality constraint [6,7]. Moreover, introducing MMSE constraint for the interference condition seems also interesting issues.

References:

[1] R. Zhang and Y.-C. Liang, "Exploiting multi-antennas for opportunistic spectrum sharing in cognitive radio networks," *IEEE J. Sel. Topics Sig. Proc*., vol. 2, no. 1, pp. 88–102, Feb. 2008.

[2] G. Scutari, D. P. Palomar, and S. Barbarossa, "Cognitive MIMO radio," *IEEE Sig. Proc. Mag.*, vol. 25, no. 6, pp. 46–59, Nov. 2008.

[3] M. Kang, B. Jung, D. Sung, and W. Choi, "A pre-whitening scheme in a MIMO-based spectrum-sharing environment," *Communication Letters*, vol. 12, no. 11, pp. 831–833, Nov. 2008.

[4] C.-B. Chae, D. Mazzarese, T. Inoue, and R. W. Heath, Jr., "Coordinated beamforming for the multiuser MIMO broadcast channel with limited feedforward," *IEEE Trans. Signal Processing*, vol. 56, no. 12, pp. 6044–6056, Dec. 2008.

[5] L. Bixio, G. Oliveri, M. Ottonello, M. Raffetto, and C. S. Regazzoni, "Cognitive radios with multiple antennas exploiting spatial opportunities," *IEEE Trans. Signal Processing*, vol. 58, no. 8, pp. 4453–4459, Aug. 2010.

[6] D. Gesbert, M. Kountouris, R. W. Heath, Jr., C.-B. Chae, and T. Salzer, "Shifting the MIMO paradigm: from single user to multiuser communications," *IEEE Sig. Proc. Mag*., vol. 24, no. 5, pp. 36-46, Oct. 2007

[7] C.-B. Chae, D. Mazzarese, N. Jindal, and R. W. Heath, Jr., "Coordinated beamforming with limited feedback in the MIMO broadcast channel," *IEEE J. Sel. Areas in Comm.*, vol. 26, no. 8, pp. 1505-1515, Oct. 2008

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Detecting Denial of Service Attacks in VoIP Networks via Wavelet Analysis

A short review for "Quick detection of stealthy SIP flooding attacks in VoIP networks"

Edited by Walid Saad

J. Tang and Y. Cheng, "Quick Detection of Stealthy SIP Flooding Attacks in VoIP Networks", in Proc. of IEEE International Conference on Communications (ICC), Kyoto, Japan, June 2011.

Denial of Service (DoS) attacks such as SIP flooding pose great threats to the VoIP services and can totally put normal network operations in jeopardy. One special form of the attacks is called the *stealthy* SIP flooding attack, in which intelligent attackers deliberately increase the flooding rates, in a slow pace so as to avoid detection. Although slow and seemingly unnoticeable, these attacks are able to gradually degrade the processing capability of the targets and bring serious damages to the network. In his paper, the authors addressed the important problem on how to quickly and accurately detect the stealthy SIP flooding attack.

A major research issue in stealthy attack detection is to counter attack schemes that do not incur immediately noticeable changes to the traffic rate. Such a challenge induces the major motivation of countering stealthy attacks: how can we find a way (beyond rate measurement) to quickly expose the changes brought in by stealthy attacks for real-time detection, and thus, quickly prevent any potential damages to the VoIP services.

Existing work cannot effectively detect the stealthy flooding attack. The intuitive volume/rate monitoring based schemes [1] [2] raise alarms when traffic volume/rate exceeds a threshold. They may gradually identify stealthy attacks, but obviously this will incur long detection delays. Other approaches utilize statistical tools for attack detection, in which alarms are raised when certain statistical property of traffic changes in consecutive time intervals [3] [4]. However, the solutions in [3] and [4] are not effective to stealthy attacks since the changes of the stochastic behavior upon each attack are too small to be identified. Some recent works applied the wavelet analysis for attack detection [5-7], but the effectiveness of wavelet in detecting stealthy attack was not exploited.

This paper reveals the power of *wavelet* for stealthy attack detection. The wavelet analysis can extract information from the raw traffic signal by decomposing the signal to different levels, i.e., approximation signal and detail signal. The basic idea is that if superficial observations cannot identify any abnormal change, the wavelet analysis can decompose the signal and extract the changes happening underneath. In particular, the work proposes to monitor the percentage of energy corresponding to the detail signal obtained from the wavelet analysis as the detector. Such a detector has the nice property of staying in a low state under the normal traffic condition; as long as the stealthy flooding attack starts, the detector will rapidly increase to the alarm state, even though there is no any visible rate change.

Moreover, this paper utilizes another technique called *sketch*. The sketch provides a configurable fixed-size raw traffic signal for wavelet analysis that is independent of the number of users in the network. This makes the wavelet based detection scheme highly scalable. In particular, the sketch generates the probability distribution information about the traffic being monitored. Applying wavelet analysis over such distribution information is an important factor leading to the quick detection, compared to directly analyzing raw traffic samples. It is shown that the wavelet based detector will lose its sharpness without assistance from the sketch technique.

As an actual indicator of the attack, the work in this paper uses the Exponential Weighted Moving Average (EWMA) to obtain a dynamic threshold. In particular, the detector freezes the threshold once it is exceeded to raise an alarm and then restarts to update the threshold after the detector is reset. Such a "threshold freezing" scheme is able to prevent the threshold from being polluted by attacks and maintain the information about normal traffic behavior even under attacks. As a side benefit, the threshold freezing period can trace the durations of attacks.

In summary, this paper shows that the proposed wavelet-based detection scheme is capable of quickly and accurately detecting the stealthy

flooding attack. Also, the sketch technique provides configurable fixed-size raw traffic signal for wavelet analysis regardless of the number of users in the network, making the detection scheme scalable. The sketch technique is also crucial to the effectiveness of the detection scheme.

Several future extensions can be envisioned. The detection of distributed stealthy flooding attacks will be an interesting topic, with the DDoS attacks becoming major threats on the Internet. Also, the detection performances with different wavelet transforms are to be compared. More theoretical studies of the wavelet-based detector are also expected. These studies can lead to novel denial of service detectors that are quick enough to handle stealthy, gradual malicious attacks.

References:

[1] B. Krishnamurthy, S. Sen, Y. Zhang and Y. Chen, "Sketch-based change detection: methods, evaluation, and applications," in *Proc. ACM SIGCOMM Conference on Internet Measurement,* pp. 234-247, 2003.

[2] R. Schweller, Z. Li, Y. Chen, Y. Gao, A. Gupta, Y. Zhang, P. Dinda, M. Kao and G. Memik, "Reverse hashing for high-speed network monitoring: algorithms, evaluation, and applications," in *Proc. IEEE INFOCOM*, pp. 1-12, Apr. 2006.

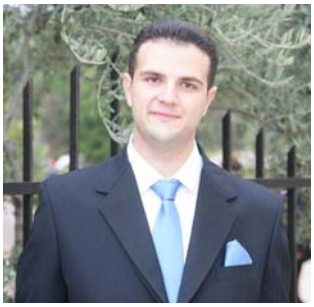
[3] H. Sengar, H. Wang, D. Wijesekera and S. Jajodia, "Detecting VoIP floods using the Hellinger distance," *IEEE Trans. Parallel Distrib. Syst.*, vol. 19, no. 6, pp. 794-805, Jun. 2008.

[4] J. Tang, Y. Cheng and C. Zhou, "Sketch-based SIP flooding detection using Hellinger distance," in *Proc. IEEE GLOBECOM*, pp. 1-6, Dec. 2009.

[5] C. Huang, S. Thareja and Y. Shin, "Wavelet-based real time detection of network traffic anomalies," in *Proc. Securecomm and Workshops*, pp. 1-7, Aug. 2006.

[6] W. Lu, M. Tavallaee and A. Ghorbani, "Detecting network anomalies using different wavelet basis functions," in *Proc. Communication Networks and Services Research Conference*, pp. 149-156, May 2008.

[7] G. Carl, R. Brooks and S. Rai, "Wavelet based denial-of-service detection," *Computers & Security*, vol. 25, no. 8, pp. 600-615, Nov. 2006.



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