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Algorithms for Efficient Digital Media Transmission over IoT and Cloud Networking

Christos Stergiou[1], Kostas E. Psannis[1*], Andreas P. Plageras[1], Yutaka Ishibashi[2], and Byung-Gyu Kim[3]

Abstract

In recent years, with the blooming of Internet of Things (IoT) and Cloud Computing (CC), researchers have begun to discover new methods of technological support in all areas (e.g. health, transport, education, etc.). In this paper, in order to achieve a type of network that will provide more intelligent media-data transfer new technologies were studied. Additionally, we have been studied the use of various open source tools, such as CC analyzers and simulators. These tools are useful for studying the collection, the storage, the management, the processing, and the analysis of large volumes of data. The simulation platform which have been used for our research is CloudSim, which runs on Eclipse software. Thus, after measuring the network performance with CloudSim, we also use the Cooja emulator of the Contiki OS, with the aim to confirm and access more metrics and options. More specifically, we have implemented a network topology from a small section of the script of CloudSim with Cooja, so that we can test a single network segment. The results of our experimental procedure show that there are not duplicated packets received during the procedure. This research could be a start point for better and more efficient media data transmission.

Key Words: Cloud Computing, Internet of Things, Digital Media, Efficient Transmission, CloudSim, Contiki OS, Cooja.

I. INTRODUCTION

Cloud Computing consists a technology of internet services, providing remote use of hardware and software. As a result, the users of Cloud Computing could have access to information and data from any place at any time. In recent years, giant companies of the IT and software sectors investigate in survey the services of Cloud Computing. Furthermore, another technology which generated relaying on Cloud Computing is Mobile Cloud Computing. Mobile Cloud Computing based on the concept of the "*Cloud*" and provides any type of information and data by no matter where and when, through mobile devices. Particularly, Mobile Cloud Computing is defined as "*the integration of Cloud Computing and Mobile technology in order to make any type of mobile devices resourceful in terms such as computational power, memory, storage and energy*". Regarding the usage of Cloud services in Mobile devices many types of services could be processed through it. Thus, high quality media could be transmitted through Cloud environment progressed in applications which were installed and operated in Cloud. Considering this Mobile Cloud Computing, and also Cloud Computing in general, could be settled as a base technology to operate other technologies, such as Internet of Things, and consequently to be accomplished an integration of Cloud and IoT [1] [2] [3] [4] [5].

Internet of Things (IoT) is "*a system of interrelated computing devices, mechanical and digital machines, objects that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction*". Based on this definition, in IoT environments could be established transmission networks for information and data produced by applications running on it. Some examples of the possible application scenarios in Internet of Things would be the domotics, e-health, assisted living, and enhanced learning. Thus, all these could lead us to the conclusion that IoT can be used in order to operate applications that provide digital media [6] [7] [8] [9].

Digital media could be produced by surveillance video systems. In most cases, surveillance is used by people in order to influence, manage, direct, or protect them, by using sensors and cameras or other compatible devices.

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Corresponding Author (*): Kostas E. Psannis, Address, +302310891737, kpsannis@uom.gr .
[1]Department of Applied Informatics, University of Macedonia, Thessaloniki, Greece, c.stergiou@uom.edu.gr, kpsannis@uom.gr, a.plageras@uom.edu.gr
[2]Department of Scientific and Engineering Simulation, Nagoya Institute of Technology, Japan, ishibasi@nitech.ac.jp
[3]Department of IT Engineering, Sookmyung Women's University, Korea, bg.kim@sookmyung.ac.kr

Ordinarily, digital media format could be defined as the high quality video format produced by surveillance cameras. Those three aforementioned technologies could be combined and operate consolidated with the aim to have a more efficient network. This network would be based on Cloud and IoT environment, for transmitting high quality data, such as digital media [10] [11] [12] [13].

The rest of the paper is organized as follows. In section 2 there is a review of the related research in the area, which deals with the integration of Cloud and IoT, as these are used as a basis for data transmission. Section 3 presents and illustrates the simulation method of this work. In Section 4 demonstrated the simulation and the experimental results recorded. Finally, section 5 provides the conclusions of the current work and offers new possibilities for the development of future work.

II. RELATED REVIEW

In this section we present related works to our research. By studying the areas of collection, delivery, management, and analysis of large-scale data (Big Data), it is concluded that data centers are responsible for everyone since everything that happens to them will affect us all. So in [14] is presented, through several open source platforms (e.g. Arduino), the implemented data center environmental monitoring system. The system's architecture design is the implementation key of success. With the implemented design and through the Internet we can identify in real-time the system logs and status. As an extension of that system is proposed the monitoring of real-time Big Data through HTML5 charts.

A region based approach is presented in [15], where Jun-Ho Huh and Kyungryong Seo discuss about efficient power consumption through the technologies and techniques of Smart Grid. The main focus area of this research is the Programmable Logic Controller (PLC) technology in conjunction with power lines for the transmission of data in a network since it is an efficient and low-cost solution for efficient metering. The results from the analysis of the implemented PLC-based power-aware home network system design, using OPNET Modeler 14.5 PL8, were analyzed and compared to those of IEEE 802.11 WLAN MAC.

In another region based approach [16], a novel power-aware routing protocol is proposed. With this protocol and a mechanism which controls the delays, researchers maximize the lifetime of every node in an Ad-hoc network system. NS-2 was the simulator used for the verification of the network.

As is known, with the blooming of Big Data, the Cloud Computing (CC) also blossomed. However, there are open issues and challenges in this technology, for some of which are provided solutions by several researchers. In [17] there is an attempt to solve the problems of ignoring the content of multimedia and the difficulty in implementing solutions for the cloud platform. So, researchers proposed a new distributed multimedia programming model for its implementation on different service platforms and different multimedia applications. Also, an algorithm for decision making by users, based on local information, is also proposed.

One of the most challenging fields of Multi-clouds is the efficient workflow scheduling. So, in [18] researchers proposed an algorithm (Multi-Clouds Partial Critical Paths, MCPCPP) for Big data scheduling in Multi-clouds. This algorithm reduces the workflows' execution costs. At the same time, the algorithm indulges the determined restriction deadline. From the results it is concluded that the proposed algorithm is promising.

Moreover, in [19] researchers talk about the networking perspectives of three popular applications. These are YouTube, Facebook, and WhatchUp. Researchers analyzed the traffic and the network infrastructure which hosts these data flows. The DBStream platform was used to analyze the large amounts of data. Solutions for traffic monitoring, analysis, and services of cellular networks have also been proposed and discussed.

The Big Data are usually transmitted from the data production center to the remote environment so that it can be provided the analysis of these large amounts of data. The multiple bandwidth reservation requests issue is discussed with the use of a High-Performance Network (HPN) in which succeeded with the best average transmission. So, in [20] have been proposed two efficient and high-speed algorithms with polynomial time complexity. The algorithms were compared with two others and from the experimental results were both verified for their advanced performance.

The pervasive network services outstretch into ubiquitous computing environment. The users to get the services they need, they have to share personal and private information. To avoid the exposure to various attacks (eg. eavesdropping) researchers proposed in [21] a security scheme to secure the communications. The authentication scheme guarantees reliability and availability by securing the remote access in Pervasive Computing Environment (PCE). The scheme provides security and convenience to the users.

III. SIMULATION METHOD

Based on previous works, with the aim to succeed a new type of network, which could provide more efficient data transmission a simulation tool was used. The simulation platform that used in this work is *CloudSim*. This simulation platform operates in the Eclipse environment, in java programming language. In *CloudSim* using the logic of a virtual system, and thus virtual management, we create Virtual Machines (VMs) [22] [23] [24] [25].

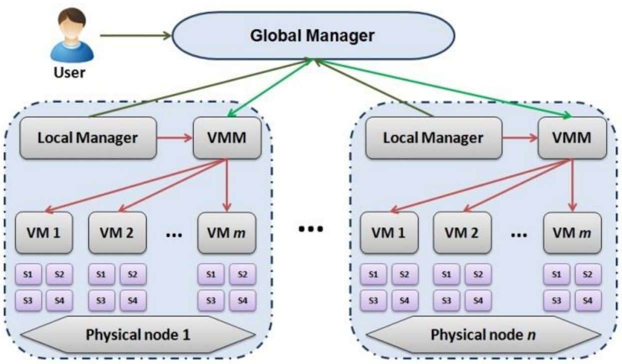


Fig. 1. Cloud System Model.

Figure 1 demonstrates how a user could interact through a *Global Manager* (application software) to a number of *Cloud Virtual Machines*. More specifically, each *Cloud Virtual* Machine consists of a Local Manager which interacts with a *Virtual Machine Manager* (VMM), and through the VMM established a communication path with the various individual VM devices. Each VM is connected to four sensors, from which it receives the data it then transmits to VMM. For each *Cloud Virtual Machine* there is a *Physical Node* which connects it to the network.

Table 1. Cloud Servers Configuration.

	Server Configuration 1	Server Configuration 2
Model	Dell PowerEdge T110	HP ProLiant ML110 G5
CPU Model	Intel E2160, 2C 1800MHz	Intel Xeon 3075, 2C 2660MHz
RAM	4GB	4GB
Network Bandwidth	1GB/sec	1GB/sec
Performance	1800 MIPS/core	2660 MIPS/core
Number of Servers Used	400	400

Table 1 lists the two types of Virtual Server Configuration for the Cloud which have been used for the simulation. In this work we used 400 Virtual Servers of the model Dell PowerEdge T110 and 400 Virtual Servers of the model HP ProLiant ML 110 G5.

Table 2. Power Consumption Information in Watt.

Consumption in %	Dell PowerEdge T110	HP ProLiant ML110 G5
0%	86	93.7
10%	89.4	97
20%	92.6	101
30%	96	105
40%	99.5	110
50%	102	116
60%	106	121
70%	108	125
80%	112	129
90%	114	133
100%	117	135

Table 2 depicts the rate of *Watt Power Consumption* from the information produced and transmitted from each type of Cloud Server, either *Dell PowerEdge T110* or *HP ProLiant G5*. As we can observe, when the rate of consumption of watts increases, both the transmission of information increases.

Table 3. Virtual Machine Configuration.

	VM 1	VM 2	VM 3	VM 4
CPU Type	High-CPU medium instance	Extra Large instance	Small instance	Micro instance
Number of Cores	1 Core	2 Cores	3 Cores	4 Cores
RAM	0.85GB	3.75GB	1.7GB	613MB
Network	1GB/sec	1GB/sec	1GB/sec	1GB/sec
Performance	2500 MIPS/core	2000 MIPS/core	1000 MIPS/core	500 MIPS/core

Table 3 shows the four types of VM that created and used for the simulation method. Each type had differentiated characteristics in order to be studied a wide range of results.

Table 4. Cloudlet Parameters.

Length (MB)	File size (MB)	Output size (MB)
5000	5000	5000

Table 4 demonstrates the Cloudlet Parameters which represent the volume of data used in a network in association with IoT technology. With the aim to proceed at a better simulate of high quality data, referring to digital data, we used large sizes in MB.

Subsequently, for further simulation procedure, we used *Cooja Contiki* simulator with the purpose of personalizing and extracting our network data in an environment with a defined topology.

IV. EXPERIMENTAL RESULTS

Having already tested the performance of the network we created in *CloudSim*, we perform a simulation in *Cooja Contiki*, where we tried to map the same network scenario, but also studied more aspects of this network.

We implement a network topology of a small part of the previous scenario where examining a single network segment. Namely, we examined the communication and the efficiency of data transmission in a VMM, which includes in its range five VMs.

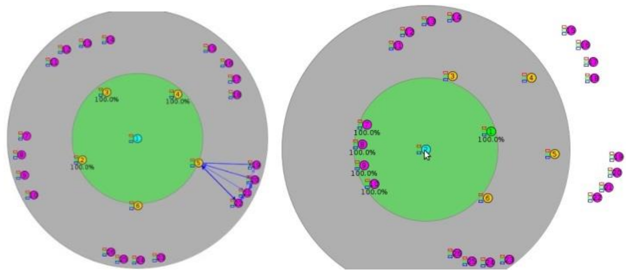
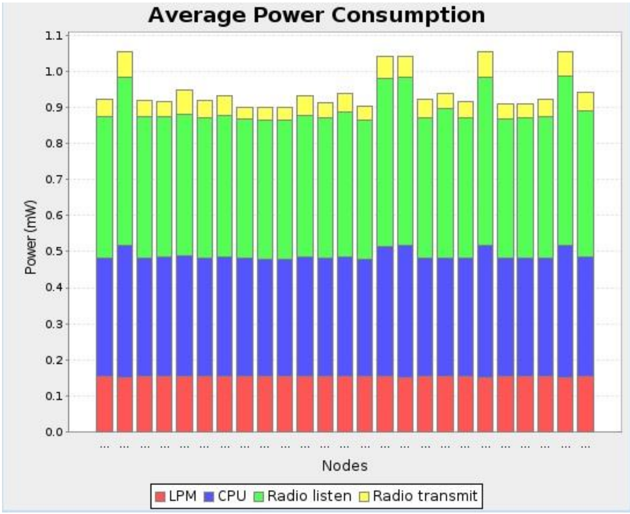


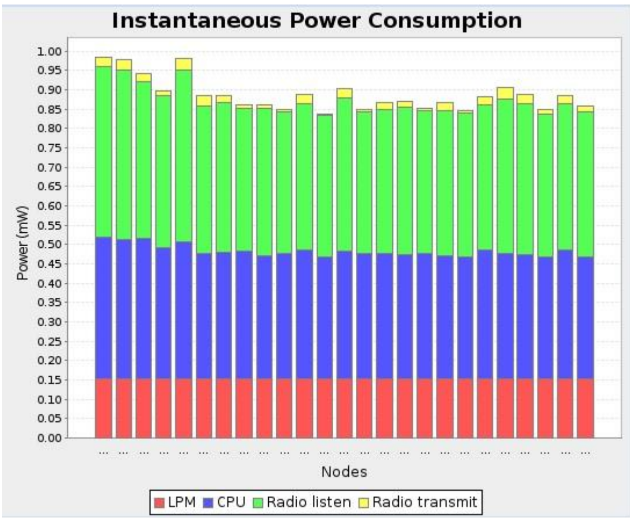
Fig. 2. Network Topology ([2a] and [2b]).

Figure 2a and Figure 2b show the topology of our proposed network. As we already mentioned, each separate part of our network consists of one VMM and five VMs. In each VM are connected four sensors. The range of the VMM contains only the five VMs, and the range of every VM contains only its four sensors. According to this, we observe that each VM contains only four sensors in its range, so as not to be inserted from the range of other VMs.

Figure 3 (a) and Figure 3 (b) demonstrates the Power Consumption of the Network. Figure 3 (a) demonstrates the average Power Consumption, where we can observe that LPM's power (red color) remains almost constant over time, as well as CPU's power (blue color). In contrast, the Radio listen's power (green color) and a little less the Radio transmit's power (yellow color) where there is a greater variation in Power Consumption. Figure 3 (b) demonstrates the Instantaneous Power Consumption, where, same as before, we can observe that LPM's power (red color) remains almost constant over time, as well as CPU's power (blue color). And also, in contrast again, the Radio listen's power (green color) and a little less the Radio transmit's power (yellow color) where there is a greater variation in Power Consumption. In Instantaneous Power Consumption we observe that there is a big difference as regards the variation of the Radio transmit's power, compared with Average Power Consumption, as there are momentary fluctuations in the change in energy consumption during transmission.



(a) Average Power Consumption.



(b) Instantaneous Power Consumption

Fig. 3. Power consumption of the proposed network.

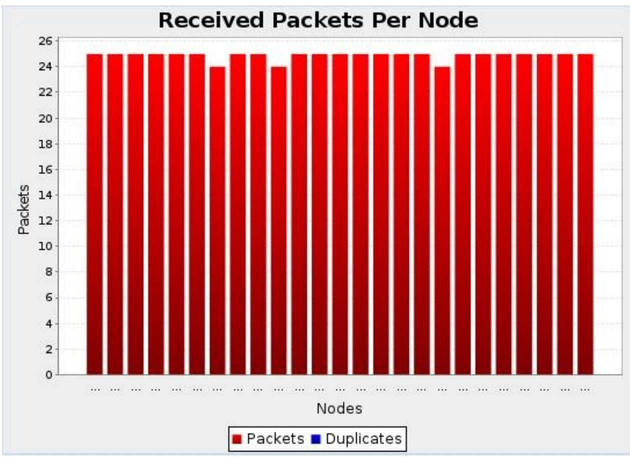


Fig. 4. Received Packets Per Node.

Figure 4 shows the transmitted packets which have been received per node. As we can observe, in most cases and almost every time all the nodes received the same number of packets. In addition to this, we can conclude that there are no duplicated packets received.

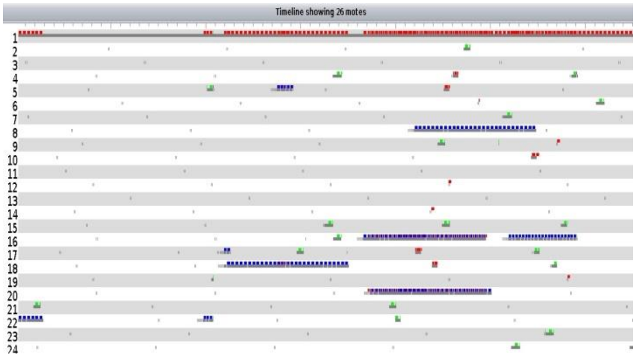


Fig. 5. Timeline showing the packets received per mote (node) over time.

Figure 5 demonstrates the packet transmission procedure through all the motes we used for the simulation in *Contiki*. With the word '*mote*' is defined the node in '*Contiki language*'. Through Figure 5, we can see that during the simulation process transmission, there are array packages with large size (large-scale data).

V. CONCLUSION

Due to the blooming of IoT in CC which takes part in the last years, the there is a need of discovering new methods of technological support in many sciences by the researchers. As part of these researches, in this work, with the aim to achieve a type of network that will provide more intelligent media-data transfer, we have studied new technologies, and the use of various open source tools, such as CC analyzers and simulators. Tool like these are useful for studying the collection, the storage, the management, the processing, and the analysis of large volumes of data. Furthermore, the simulation platform used is CloudSim and operates on Eclipse environment. Thus, after measuring the network performance with CloudSim, we use the Cooja emulator of the Contiki OS in order to confirm and access more metrics and options. As a result, we implemented a network topology from a small section of the script of CloudSim with Cooja, so that we can simulate a single network segment. The results of the experiment show that there are not duplicated packets received.

Finally, as future research, we suggest a further examination of the simulation analysis of the network performance in CloudSim simulator, and other simulation platforms, with the aim to have a better and improved contribution of the technology of Internet of Things with the additional 'help' of the Cloud Computing technology for the purpose of better transmission of high quality data. This research could be a start point for better and more efficient media data transmission.

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Authors

Christos Stergiou is currently a PhD student in the Department of Applied Informatics, School of Information Sciences, University of Macedonia, Greece. His main research interests include Algorithms for Cloud Computing, Big Data and Wireless Communication. In 2017, he was awarded by the conference committee of 19th IEEE Conference on Business Informatics (CBI) for Doctoral Student Work titled "Algorithms for Big Data in Advanced Communication Systems and Cloud Computing".

Kostas E. Psannis was born in Thessaloniki, Greece. Kostas received a degree in Physics from Aristotle University of Thessaloniki (Greece), and the Ph.D.

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degree from the Department of Electronic and Computer Engineering of Brunel University (UK). From 2001 to 2002 he was awarded the British Chevening scholarship sponsored by the Foreign & Commonwealth Office (FCO), British Government. He was awarded, in the year 2006, a research grant by IISF (Grant No. 2006.1.3.916). Since 2004 he has been a (Visiting) Assistant Professor in the Department of Applied Informatics, University of Macedonia, Greece, where currently he is Assistant Professor (& Departmental LLP/ Erasmus-Exchange Students Coordinator and Higher Education Mentor) in the Department of Applied Informatics, School of Information Sciences. He is also joint Researcher in the Department of Scientific and Engineering Simulation, Graduate School of Engineering, Nagoya Institute of Technology, Japan. He has extensive research, development, and consulting experience in the area of telecommunications technologies. Since 1999 he has participated in several R&D funded projects in the area of ICT (EU and JAPAN). Kostas Psannis was invited to speak on the EU-Japan Co-ordinated Call Preparatory meeting, Green & Content Centric Networking (CCN), organized by European Commission (EC) and National Institute of Information and Communications Technology (NICT)/ Ministry of Internal Affairs and Communications (MIC), Japan (in the context of the upcoming ICT Work Programme 2013) and International Telecommunication Union (ITU) SG13 meeting on DAN/CCN, July 2012, amongst other invited speakers. He has several publications in international Conferences, books chapters and peer reviewed journals. His professional interests are: Multimodal Data Communications Systems, Haptic Communication between Humans and Robots, Cloud Transmission/Streaming/Synchronization, Future Media-Internet of Things, Experiments on International Connections (E- ICONS) over TEIN3 (Pan-Asian), Science Information Network (SINET, Japan), GRNET (Greece)-Okeanos Cloud, and GEANT (European Union) dedicated high capacity connectivity. He is Guest Editor for the Special Issue on Architectures and Algorithms of High Efficiency Video Coding (HEVC) Standard for Real-Time Video Applications (2014), Journal of Real Time Image Processing (Special Issue). He is Guest Editor for the Special Issue on Emerging Multimedia Technology for Smart Surveillance System with IoT Environ-ment (2016), The Journal of Supercomputing (Special Issue). He is Guest Editor for the Special Issue on Emerging Multimedia Technology for Multimedia-centric Internet of Things (mm-IoT) (2016), Multimedia Tools and Applications (Special Issue). He is currently GOLD member committee of IEEE Broadcast Technology Society (BTS) and a member of the IEEE Industrial Electronics Society (IES). From 2017 Prof. Kostas E. Psannis serving as an ASSOCIATE EDITOR for IEEE ACCESS and IEEE Communications Letters. He is also a member of the European Commission (EC) EURAXESS Links JAPAN and member of the EU-JAPAN Centre for Industrial Cooperation.

Andreas P. Plageras is currently a PhD student in the Department of Applied Informatics, School of Information Sciences, University of Macedonia, Greece. His main research interests include Algorithms for Big Data delivery over Internet of Things.

Yutaka Ishibashi received the B.E., M.E., and Ph.D. degrees from Nagoya Institute of Technology, Nagoya, Japan, in 1981, 1983, and 1990, respectively. In 1983, he joined the Musashino Electrical Communication Laboratory of Nippon Telegraph and Telephone Corporation (NTT), Japan. From 1993 to 2001, he served as an Associate Professor of Department of Electrical and Computer Engineering, Faculty of Engineering, Nagoya Institute of Technology. Also, he was a Visiting Researcher, Department of Computer Science and Engineering, University of South Florida (USF) (2000–2001). Currently, he is a Professor of Graduate School of Engineering, Nagoya Institute of Technology. His research interests include networked multimedia, multimedia QoS (Quality of Service) control, and multi-sensory communication. He was the Chair of the IEICE Communication Quality Technical Committee (2007–2009). He also served as the Guest Editor-in-Chief of IEICE Transactions on Communications, Special Section on Quality of Communication Networks and Services, General Co-Chair of Annual Workshop of Network and Systems Support for Games (NetGames) in 2006, 2010, and 2014, and Technical Program Chair of IEEE International Communications Quality and Reliability (CQR) Workshop in 2010 and 2011. He is a fellow of IEICE and a member of IEEE, ACM, IPSJ, ITE, VRSJ, and IEEJ.

Byung-Gyu Kim has received his B.S. degree from Pusan National University, Korea, in 1996 and an M.S. degree from Korea Advanced Institute of Science and Technology (KAIST) in 1998. In 2004, he received a Ph.D. degree in the Department of Electrical Engineering and Computer Science from Korea Advanced Institute of Science and Technology (KAIST). In March 2004, he joined in the real-time multimedia research team at the Electronics and Telecommunications Research Institute (ETRI), Korea where he was a senior researcher. In ETRI, he developed so many real-time video signal processing algorithms and patents and received the Best Paper Award in 2007. From February 2009 to February 2016, he was associate professor in the Division of Computer Science and Engineering at SunMoon University, Korea. In March 2016, he joined the Department of Information Technology (IT) Engineering at Sookmyung Women's University, Korea where he is currently an associate professor. In 2007, he served as an editorial board member of the International Journal of Soft Computing, Recent Patents on Signal Processing, Research Journal of Information Technology, Journal of Convergence Information Technology, and Journal of Engineering and Applied Sciences. Also, he is serving as an associate editor of Circuits, Systems and Signal Processing (Springer), The Journal of Supercomputing (Springer), The Journal of Real-Time Image Processing (Springer), The Scientific World Journal (Hindawi), and International Journal of Image Processing and Visual Communication (IJIPVC). He also served as Organizing Committee of CSIP 2011 and Program Committee Members of many international conferences. He has received the Special Merit Award for Outstanding Paper from the IEEE Consumer Electronics Society, at IEEE ICCE 2012, Certification Appreciation Award from the SPIE Optical Engineering in 2013, and the Best Academic Award from the CIS in 2014. He has been honored as an IEEE Senior member in 2015. He has published over 150 international journal and conference papers, patents in his field. His research interests include software-based image and video object segmentation for the content-based image coding, video coding techniques, 3D video signal processing, wireless multimedia sensor network, embedded multimedia communication, and intelligent information system for image signal processing. He is a senior member of IEEE and a professional member of ACM, and IEICE.